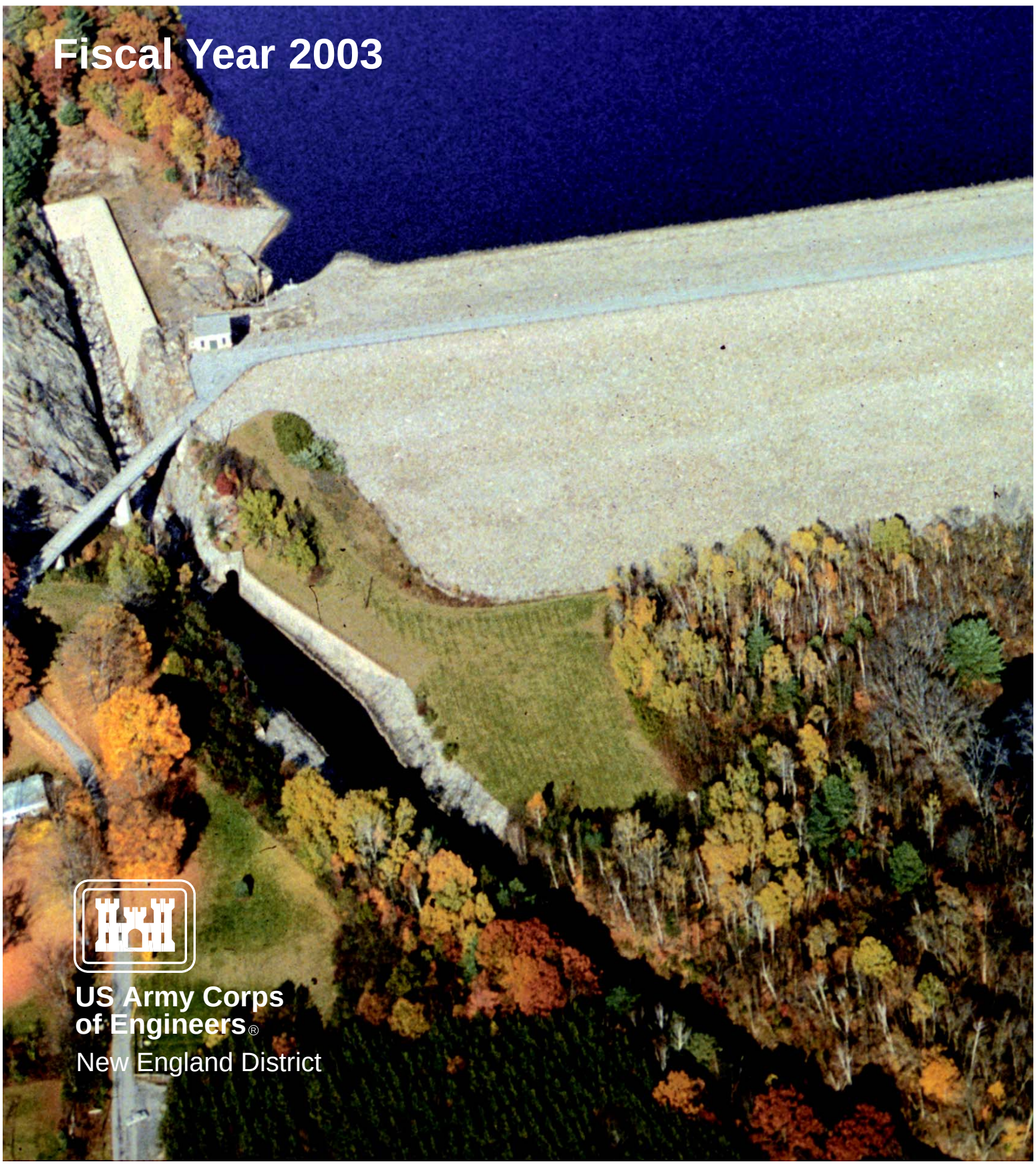
Annual Water Quality Report

Fiscal Year 2003



US Army Corps
of Engineers®
New England District

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WATER QUALITY CONTROL MANAGEMENT PROGRAM
ANNUAL REPORT
FISCAL YEAR 2003

JANUARY 2004

FOREWORD

While the New England office of the Corps was an independent division, regulations required us to submit an annual water quality report to the Chief of Engineers in Washington, D.C. When the New England office became a district under North Atlantic Division (NAD) in 1997 the annual reporting requirements changed. We prepare and send information to NAD that they use to prepare the required report to Washington. While we are no longer required by regulation to prepare an annual report in this format, we continue to do so because it meets our needs for recording and reporting what happened during the year.

This Fiscal Year 2003 Annual Water Quality Report of the New England District is a continuation of reports that began in 1978. Information contained herein updates that presented reports prepared through FY98. Duplication of previous information has been kept to a minimum.

Mr. Townsend Barker of the Water Management Section prepared this report and is available to provide additional information on areas of further interest (telephone: 978-318-8621).

NEW ENGLAND DISTRICT
WATER QUALITY CONTROL MANAGEMENT
ANNUAL REPORT
FISCAL YEAR 2003

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1. GENERAL BACKGROUND

NAE has completed 35 dams, 5 hurricane barriers, and 112 local protection projects within the New England area. Figure 1 shows locations of the dams. In addition, NAE has acquired flowage rights on more than 8,000 acres of flood-prone Massachusetts lands within the Charles River Natural Valley Storage area. All local protection projects, four dams, and three hurricane barriers have been turned over to local interests, and the remainder are operated and maintained by NAE. Most construction prior to 1955 was authorized for flood control purposes only; however, approval has been given for other uses at many of NAE's older reservoirs, due to development of new water resource needs in the basins. Most of the newer projects have been designed for more than flood control storage, e.g., recreation, conservation, and low flow augmentation; furthermore, Littleville and Colebrook River Lakes have significant water supply storage. Hydropower facilities have been constructed at seven sites on Corps-owned lands; however, these are designed, built, operated, and maintained by private interests not connected with the Corps.

Although water quality management is not a defined purpose at any project operated and maintained by NAE, the Corps has a long-standing, strong interest in water quality. Executive Order 11752, "Prevention, Control, and Abatement of Environmental Pollution at Federal Facilities," 19 December 1973, makes it a stated national policy that the Federal Government, in the design, construction, and operation of its facilities, shall provide leadership in the nationwide effort to protect and enhance the quality of our air, water, and land resources. Section 102b, of the Federal Water Pollution Control Act Amendments of 1972 places responsibility with EPA for determination of the need for, the value of, and the impact of storage for water quality control in reservoir projects constructed after 1972. Responsibility for water quality management at Corps projects, however, clearly rests with the Corps since it is an integral part of our water control management activities. To meet this responsibility, area-wide water quality management programs must be established, specific water quality objectives for each reservoir area-wide water quality management programs must be established, specific water quality objectives for each reservoir project developed, and procedures implemented to meet these objectives. To

NAE RESERVOIR PROJECTS INCLUDED IN ITS
WATER QUALITY MANAGEMENT PROGRAM

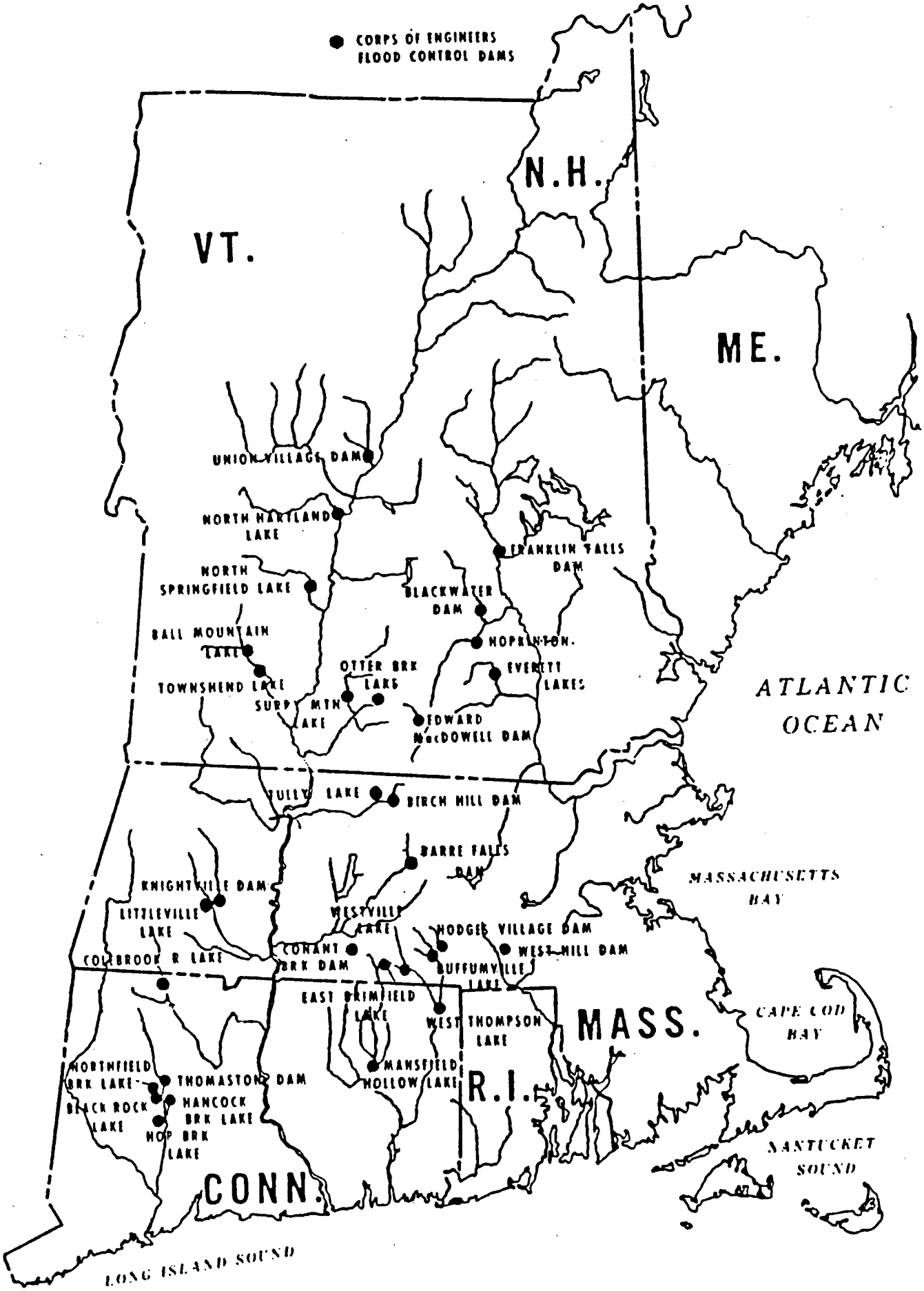

FIGURE 1

ensure success, continual collection and evaluation of water quality data and reporting of water quality management activities are necessary. The Annual Water Quality Reports, required of each Corps Division, are part of that program of evaluation and reporting.

NAE's reservoir water quality control management program has multiple goals. Its primary purpose is to protect public health and safety, but additional goals include meeting State water quality standards, maintaining water quality suitable for all project purposes, and understanding the effects of project operations on water quality. The Master Water Control Manual for each basin includes the goals and objectives for the water quality program.

This annual report is a summary of water quality conditions and activities during the year. In addition to meeting North Atlantic Division's reporting requirements, it is a valuable tool for reviewing the past year's program and charting the course for the following year. This report is not limited to activities under the Corps Reservoir Water Quality Operations and Maintenance Program, but includes other Corps water quality activities and concerns related to various studies, investigations, and designs.

2. SUMMARY

The FY03 (1 October 2002 through 30 September 2003) NAE reservoir water quality control management program was similar to that presented in the FY02 Annual Water Quality Report (AWQR). Total program size was equal to $237,000, an increase of 0.5 percent from the previous year. No changes were made in the basic structure of NAE's classes I, II, and III water quality classification system (described in Appendix A). The water quality team formed in 1982, with representatives from Engineering/Planning and Construction/Operations Divisions continued setting direction for the overall water quality program and coordinated all its elements.

FY03 had heavy snowfall in New England with a cool wet spring followed by a warm summer. Precipitation as a whole was a little above average. Algal blooms were generally light due to flushing from wet weather, although they were heavier than usual at West Thompson Lake in the fall. Beach closures, which are generally related to wet weather, were more common than in FY02, which had a very dry summer. Otherwise, it was a fairly typical year for water quality conditions.

Water quality was good to excellent at most projects with concerns generally caused by external phenomena, such as upstream nonpoint source discharges or acid precipitation. By "good water quality" we mean the water generally met or exceeded State standards, and was suitable for its intended uses, which at most projects was recreation, and fish and wildlife habitat. Table 1 contains current NAE classifications of existing reservoir projects. State water quality classifications are listed in Appendix B.

Activities performed by NAE in FY03 under the Reservoir Water Quality Operation and Maintenance Program included

- Potable water and bathing beach water quality monitoring.

- Baseline monitoring of class III projects without conservation pools, class II and half the class I projects with conservation pools.

- Completion of a report on the Northfield Brook Lake priority pollutant scan.

- Investigation of a fish kill at Deweys Mills Pond at North Hartland Lake.

- Fishery investigations on the West River at Ball Mountain and Townshend Lakes.

- Fishery investigations at Tully Lake.

- Water quality studies at Dewey's Mill Pond.

- Updated water quality evaluations for Barre Falls Dam and Hop Brook and Buffumville Lakes.

Water quality activities performed in FY03 as part of other studies, investigations, and designs included

- Continuation of the Merrimack River basin study.

- Continuation of Dwarf Wedgemussel studies at Surry Mountain Lake.

- Continuation of Osgood Pond aquatic ecosystem restoration study.

TABLE 1

NAE RESERVOIR PROJECT CLASSIFICATION
1 JANUARY 2004

Class III	Class II	Class I
Six projects with definite water quality problems.	Six projects with minor water quality problems.	Nineteen projects with no significant water quality problems.
Three Lakes	Five Lakes	Thirteen Lakes
Hop Brook, CT	North Hartland, VT	Ball Mountain
Northfield Brook, CT	Hopkinton, NH	North Springfield, VT
West Thompson, CT	Buffumville, MA	Townshend, VT
	East Brimfield, MA	Edward MacDowell, NH
	Tully, MA	Everett, NH
		Otter Brook, NH
		Surry Mountain, NH
		Littleville, MA
		Westville, MA
		Black Rock, CT
		Colebrook River, CT
		Hancock Brook, CT
		Mansfield Hollow, CT
Three Dry-Bed Reservoirs	One Dry-Bed Reservoir	Six Dry-Bed Reservoirs
Birch Hill, MA	Thomaston, CT	Blackwater, NH
West Hill, MA		Franklin Falls, NH
Union Village, VT		Barre Falls, MA
		Conant Brook, MA
		Hodges Village, MA
		Knightville, MA

- Initiation of a study to improve water quality at Straits Pond.

- Continuation of salt marsh restoration studies.

- Continuation of assistance HTRW cleanups.

Water quality personnel at NAE continued coordinating with Federal, State, and local officials regarding mutual water quality concerns. In an effort to promote information exchange, copies of this report are being provided to relevant State and Federal agencies and interested private parties.

Appendix C contains a summary of reservoir water quality control management reports.

3. RESERVOIR WATER QUALITY OPERATION AND MAINTENANCE PROGRAM

a. Water Quality Team. NAE's water quality team (WQT), established in 1982 with members from Engineering and Operations Directorates, continued to run the program in 2003. Mr. Bruce Williams of Technical Services Branch represented Construction/Operations, Mr. William Hubbard, Chief Environmental Resources Section represented Planning, and Mr. Townsend Barker of the Water Resources Branch continued as Engineering's representative and chaired the team. Table 2 contains a summary of experience levels of members of the water quality team, and the principals involved in carrying out the water quality programs.

b. Potable Water Quality Monitoring. During FY03 NAE monitored 49 drinking water wells at 25 reservoir projects on a regular basis; 24 of these wells are registered as public water supplies and all of these meet the definitions of transient, non-community systems. In accordance with requirements of the Environmental Protection Agency's "Total Coliform Rule," sampling frequency is based on expected monthly usage as predicated from past records. Biweekly, monthly, or quarterly samplings are called for during the recreation season. Drinking fountains at NAE's recreation areas are open from approximately the third Saturday in May to the weekend after Labor Day. Monitoring could vary on a monthly basis according to the actual number of visitors expected. However, for simplicity's sake, sampling at each project, during the recreation period, was set according to the expected maximum monthly attendance for the year. During the remainder of the year, wells kept open for project personnel are monitored quarterly. Monitoring for other parameters is performed as required by the States in which the wells are located.

TABLE 2
WATER QUALITY STAFF

EMPLOYEE	SECTION	POSITION TITLE	GRADE	YEARS OF EXPERIENCE	AREAS OF EXPERTISE
Barker, T.*	Water Management	Hydraulic Engineer	GS-12	29	Water chemistry, computer modeling, environmental engineering, hydrologic engineering
Geib, M.	Water Management	H&H Team Leader	GS-13	27	Technical review, hydrologic engineering, computer modeling
Hubbard, W.*	Environmental Resources	Environmental Resource Specialist	GS-13	25	Aquatic ecology, benthic interactions, habitat restoration, environmental regulations
Levitt, K.	Environmental Resources	Biologist	GS-12	20	Fisheries biology, limnology, aquatic microbiology
McNally, N.*	Water Management	Physical Science Technician	GS-9	17	Sample collection, HTW
Miller, K.	Water Management	Chemist	GS-11	13	Chemistry, sample collection
Trinchero, P.	Environmental Resources	Biologist	GS-11	31	Fisheries biology, limnology, aquatic microbiology, ecology
Williams, B.*	Operations Technical Support	Park Manager	GS-12	24	Wildlife biology, wetlands, environmental compliance and restoration
Wood, D.	Water Management	Hydraulic Engineer	GS-12	29	Environmental engineering, computer modeling, hydrologic engineering

*Primary participants in the reservoir water quality program.

Massachusetts, New Hampshire and Vermont require public water systems to be operated by certified operators; all NAE systems in those states are maintained by licensed VSSO's – very small system operators. Table 3 contains a summary of the projects, by state, where NAE monitors potable water quality.

The minimum amount of monitoring required to show that systems are in compliance with State and Federal standards is referred to as the "compliance" monitoring. NAE has found through experience that a higher level of monitoring is desirable at our wells than the absolute minimum of the compliance samples, but the State agencies do not consider the additional samples to have the regulatory importance of the compliance samples. For example, a finding of coliform bacteria in a compliance sample will result in a boil order until a sufficient number of samples have come back clean. However, if coliforms are found in a sample that was not required as part of the compliance monitoring, the State will usually allow the well to be reopened after getting one clean sample, if the well has been chlorinated and flushed.

Compliance monitoring requirements vary with the states. Massachusetts requires monthly sampling of total coliforms. New Hampshire requires quarterly monitoring of total coliform levels and specifies the months when compliance samples must be collected. Connecticut also requires quarterly monitoring of total coliforms but does not specify the months, and Vermont requires only an annual compliance total coliform analysis. Annual monitoring of nitrate is required by all four states, but only New Hampshire and Massachusetts specify the quarter the samples must be collected. Connecticut requires quarterly monitoring of color, odor, pH, and turbidity, but the other three states do not. Nitrite monitoring is required every year by Connecticut but only once every 3 years by Massachusetts and New Hampshire, and only once by Vermont. During FY03 nitrite was analyzed at the 4 Connecticut projects, Hopkinton and Otter Brook Lakes in New Hampshire, and Buffumville Lake and West Hill Dam in Massachusetts. Massachusetts requires sodium analyses every three years, and in FY03 it was measured at Buffumville Lake and West Hill Dam; the other three states do not require sodium analyses.

NAE samples the wells, but contract laboratories perform bacteria and other analyses. Laboratories used included Microbac in Marlborough, Massachusetts for Massachusetts total coliform and nitrate analyses and occasional Connecticut coliform analyses; Environmental Alternatives, Inc. (formerly Biological Services) in Keene for New Hampshire and some Vermont total coliform analyses; Aquacheck Water Testing Laboratory, in Weathersfield, Vermont for Vermont total coliform

TABLE 3

POTABLE WATER QUALITY MONITORING
AT NAE RESERVOIR PROJECTS IN 2003

	Wells Monitored	Public Water Supply Wells
Vermont		
Ball Mountain Lake	6	3
North Hartland Lake	1	1
North Springfield Lake	2	1
Townshend Lake	3	2
Union Village Dam	2	1
New Hampshire		
Blackwater Dam	1	0
Edward MacDowell Lake	1	1
Everett Lake	1	0
Hopkinton Lake	3	2
Otter Brook Lake	2	1
Surry Mountain Lake	2	1
Massachusetts		
Barre Falls Dam	2	0
Birch Hill Dam	1	0
Buffumville Lake	2	1
East Brimfield Lake	0	1*
Knightville Dam	3	2
Littleville Lake	1	0
Tully Lake	1	1*
West Hill Dam	3	2
Connecticut		
Colebrook River Lake	1	0
Hop Brook Lake	4	2
Mansfield Hollow Lake	1	0
Northfield Brook Lake	2	2
Thomaston Dam	1	1
West Thompson Lake	3	1

*Public wells on Corps property operated and monitored by others.

and nitrate analyses for Vermont and New Hampshire wells; and Northeast Laboratories Inc. in Berlin for most Connecticut samples.

Analytical results from the compliance samples collected at public wells are sent to the appropriate State agencies, but different states have different requirements for reporting monitoring results. Massachusetts and New Hampshire require results be reported to them within 24 hours. Connecticut requires reporting of results by the ninth day of the following month, and Vermont does not require a report of results until the end of the year.

Drinking water standards require less than one total coliform bacterium per 100 ml. Wells showing possible contamination are closed, chlorinated, flushed, and retested. If retesting shows the well to be safe, it is reopened. However, wells may also be closed for other reasons, including excessive turbidity or non-coliform bacteria.

An unusually large number of wells tested positive for coliform bacteria during FY03. At Hop Brook Lake in Connecticut, Surry Mountain and Hopkinton Lakes in New Hampshire, and Ball Mountain, North Hartland, and Townshend Lakes and Union Village Dam in Vermont, one or more wells tested positive for total coliforms at least once during the year. However, no wells tested positive for *E. coli*, and no wells failed to meet standards for parameters other than bacteria.

When the well at the old utility building at Ball Mountain Lake was tested in late March prior to the start of the recreation season, it had a high total coliform count. This well had previously failed once in 2001 and twice in 2002, and when it failed again in 2003, Ms. McNally inspected the system and found that the old casing was in a manhole with a vent that was below ground level. Water levels in the manhole were occasionally getting high enough for water to be pulled into the well through the vent. Compounding this problem was that it was extremely difficult to chlorinate the well without making a confined-space entry into the manhole. A contract was let to extend the casing above grade and backfill the manhole, but spring rains kept water levels high and it wasn't until the beginning of June that the work was finished. When the well was tested, total coliforms were again found in the system, but this was attributed to poor flushing. After the system was flushed for a couple of hours, it tested clean in June and for the rest of the year.

In July the two recreation area wells at Townshend Lake repeatedly testing positive for total coliforms. An investigation by Ms. McNally of the 5000-gallon storage tank on the top of a hill found that the vents were not screened, one of the

openings was not threaded, and organic material was getting into the tank. She advised the project manager to fix the vents, drain the tank, add chlorine, refill it, draw the chlorinated water into the lines, let it sit overnight, and then flush the system. The system subsequently tested clean.

In July the well at the ranger station restroom tested positive for total coliforms. After the line was chlorinated and flushed, it tested clean the following week.

Plumbing work at North Hartland Lake in July and Union Village Dam in August were the likely reasons for wells at those projects testing positive for total coliforms. Both tested clean after the lines were chlorinated and flushed.

Flood-control regulation in late August at Surry Mountain Lake due to heavy rains inundated the well servicing the recreation area, and it began repeatedly testing positive for total coliforms at multiple locations on the lines. Repeated chlorination and flushing of the lines were required before the system tested clean.

New Hampshire performs sanitary surveys at all public water supplies with a minimum frequency of every 5 years for transient non-community systems. This includes laboratory analyses for coliforms, nitrate, nitrite, pH, chloride, fluoride, sodium, copper, iron, lead, and manganese. In September 2003 they did a survey at Surry Mountain Lake's well. Results showed excellent water quality that easily met all standards.

The project manager for Blackwater Dam complained of "brown water" coming from the tap at the project office. A sample collected on 2 September had a turbidity of 7 NTU's and an iron level of 660 ug/l. Turbidity is a concern in drinking water because it can protect bacteria from chlorination, but that is not an issue for a deep well such as this that is not directly affect by surface water. The iron level, however, exceeds the national secondary drinking water criterion of 300 ug/l, which is set to prevent unpleasant tastes and other nuisance problems. As a result of this finding, and the limited use that this well gets, the project manager will be supplying bottled water for drinking at the project.

In addition to the regularly monitored wells, there are two projects that have wells at camping areas that are run by other groups but that NAE has occasionally been asked to monitor over the years. These are well number EB-DW-1 at East Brimfield Lake's Holland Pond recreation area that is run by the state, and TM-DW-2 at the Tully Lake campground, which is run by the Trustees of Reservations. These were not monitored by the Corps during FY02. Also there are projects including

Everett and North Hartland Lakes and Birch Hill Dam that have wells at recreation areas run by the states that have never been part of the NAE potable water monitoring program.

c. Bathing Beach Water Quality Monitoring. NAE takes monitoring of water quality at the beaches it operates and maintains very seriously. In addition to keeping abreast of changing state standards, we sample more frequently than the minimum required by regulations at beaches that we know have problems, use innovative approaches to deal with projects that have high bacteria counts after rainstorms, and partner with local and state health departments to deal with beaches with chronic problems.

We also collect other information for every beach sample including recent precipitation amounts, temperature, algae, and number of geese as a reference if the bacteria count comes back high. Appendix D has a sample of the form that is used and shows the information that is recorded. This form was revised in 2003,

State standards are used to determine which indicator organisms are monitored at each beach and the minimum frequency of sampling. In 2002 Connecticut joined Massachusetts, New Hampshire, and Vermont in adopting *Escherichia coli* as the indicator organism for monitoring freshwater beaches in FY02, although each of these states has its own numerical criteria. Connecticut also began requiring weekly monitoring of beaches in 2002. Table 4 contains a summary of indicator organisms and standards for the states where NAE monitors beaches.

(1) FY03 Activities. There were only minor changes in the beach monitoring in FY03 from FY02. Connecticut, Massachusetts, New Hampshire, and Vermont all use *Escherichia coli* as the indicator organism for beach monitoring, and all but New Hampshire require weekly monitoring of beaches. New Hampshire is considering requiring weekly monitoring at all beaches, but currently monitors beaches weekly to monthly based on usage. The number of swimming areas in the water quality program remains at 14. The only changes were that the beach at Hop Brook Lake was sampled at two locations, instead of the previous one, in compliance with Connecticut regulations for a beach of its size, and we stopped collecting samples at the possible future beach site at West Thompson Lake. Table 5 contains a summary of projects, by State, where water quality for bathing is monitored by NAE.

TABLE 4

2003 BEACH-MONITORING STANDARDS

State	Indicator Organism	Standard (per 100 ml) Not to Exceed	Geometric Mean
Connecticut	*Escherichia coli* (*E. coli.*)	235	126
Massachusetts	*Escherichia coli* (*E. coli.*)	235	126
New Hampshire	*Escherichia coli* (*E. coli.*)	88	47[1]
Vermont	*Escherichia coli* (*E. coli.*)	77	--

Beaches maintained by NAE are monitored during the recreation period that runs from about the third weekend in May until Labor Day. Beach failures were more common in FY03 than in the previous year, possibly due to a greater amount of rain. Samples from beaches at Ball Mountain, Buffumville, Hop Brook, Northfield Brook, Otter Brook, Surry Mountain, and Townshend Lakes, and Union Village and West Hill Dams failed to meet swimming standards on one or more days each during FY03.

There is no official swimming area at Tully Lake, but the park manager and the Royalston Board of Health were concerned because swimming does occur there, especially among people using the State-operated campground. Swimming at one's own risk is permitted according to Title 36 of Corps regulations governing public use of water resources projects administered by the Corps. However, the Corps park manager was concerned that people were swimming in untested waters and that the Corps should be proactive in dealing with this. Testing at Tully Lake showed generally only very low levels of bacteria and the site easily met state standards. This was likely due in part to the generally undeveloped nature of its watershed, but also to the naturally low pH of the water that discourage bacterial survival.

1 To meet NH class B standards for a designated beach area, a geometric mean based on at least 3 samples obtained over a 60-day period should not exceed 47 E. coli. per 100 ml. However, NH does not apply this geometric mean to samples collected over a shorter period. For example, if a single sample exceeds 88 but three additional samples collected over the next week are all below 88, the beach can be reopened even if the geometric mean is greater than 47 per 100 ml.

TABLE 5

BATHING BEACH WATER QUALITY MONITORING
AT NAE RESERVOIR PROJECTS

Vermont	Locations Monitored
Ball Mountain Lake	1
North Hartland Lake	1
North Springfield Lake	1
Townshend Lake	1
Union Village Dam	1
New Hampshire	
Edward MacDowell Lake	1
Hopkinton Lake	1
Otter Brook Lake	1
Surry Mountain Lake	1
Massachusetts	
Buffumville Lake	1
West Hill Dam	1
Tully Lake	1
Connecticut	
Hop Brook Lake	1
Northfield Brook Lake	1

In FY03 we again had problems getting good *E. coli* data for Connecticut projects. We were getting counts of 0 per 100 ml at Hop Brook Lake from our contract lab on days when the Waterbury Sanitarian was also sampling and getting high counts from the Connecticut State Lab. Ms. McNally discussed the 0 counts with the lab director, and he investigated and found that one of the technicians was incubating the plates in a manner that was heating them too much. Ms. McNally then met with the Waterbury Sanitarian and showed him the proper method for collecting

samples. We began sending split samples to our contract labs and the State Lab and getting reasonable comparisons among them. We had to send samples to the State Lab through the local health departments because we were contractually unable to send them directly. The Waterbury Sanitarian ceased collecting samples at Hop Brook Lake after becoming convinced that the Corps was doing as good a job if not better than he was; however, he wanted the Corps to collect split samples the third week of the month and send one to the Connecticut State Lab for quality control.

Ball Mountain Lake had more than the usual number of beach closings due to elevated bacteria counts in 2003, apparently due to rain events as Canada geese were not present in significant numbers. None of these events caused beach standards to be exceeded for more than 2 or 3 days. Elevated bacteria counts were recorded in mid and late July, early and mid-August, and the day after Labor Day. Bacteria counts exceeded standards at this beach for an estimated total of 8 days in 2003, compared to no exceedences in 2002.

Buffumville Lake had one bacteria count a little in excess of beach standards in early July, but sampling two days later and for the rest of the season had acceptable counts. It had not rained in more than a week and there were no geese or droppings in the vicinity at the time of sampling, so there was no obvious explanation for the elevated count. However, the project has had some problems with geese and they might have been the source. Bacteria counts exceeded standards at this beach for an estimated total of 2 days in 2003, compared to 15 days in 2002.

Otter Brook and Surry Mountain Lakes each exceeded beach standards on one day in 2003. On 4 August, following significant rain, the beach standard of 88 per 100 ml was exceeded, but the beaches had already been closed as a precaution due to the heavy rain. Resampling on 6 August showed acceptable levels at both projects. Bacteria counts exceeded standards at these beaches for an estimated total of 4 days each in 2003. There were no exceedences of beach standards at either project in 2002.

Mid-August rains caused the beach standard to be exceeded at Townshend Lake on 18th and 20th, but testing on the 22nd showed acceptable levels and there were no other problems at that beach for the rest of the year. Bacteria counts exceeded standards at this beach for an estimated total of 4 days in 2003, compared to no exceedences in 2002.

Hop Brook Lake did not have any beach closures due to elevated bacteria counts in 2002 (although there were administrative closures after rainfall), which

was highly unusual for that project, but in 2003 there was a more normal pattern with multiple exceedences of standards. When standards are exceeded at this project, it is usually after rain events, but the flocks of Canada geese that congregate there also seem to be part of the problem. The beach was closed for about a week in late May and early June following heavy spring rains. A four-day closing during the last week of June followed another heavy rainstorm, but high counts on the last day of June and the end of the first week in July came after only 0.14 inches of rain on the previous day. It is likely that droppings from the 39 to 40 Canada geese observed at the project on those days caused the high bacteria counts. Rain and large numbers of geese kept counts above standards for most of the last two weeks in July and the first three weeks in August. During this period when samples were collected from both ends of the beach, there were often much higher bacteria counts where the geese were congregating. Bacteria counts exceeded standards at this beach for an estimated total of 49 days in 2003; there were no measured bacteria levels in excess of standards in 2002, although there were administrative closures after significant rain.

Like Hop Brook Lake, Northfield Brook Lake returned to a more normal season of multiple beach closures in 2003 after having none in the previous year (except for administrative closures after rainfall). Heavy rain in late May and late June triggered administrative closures even before bacteria testing showed elevated levels. Recurring rains caused bacteria levels to exceed standards for two weeks in early August; the return of Canada geese to the project may also have been a factor. Heavy rain at the beginning of September caused high counts and the early closure of the beach for the season. Through administrative closures or measurements of bacteria counts exceeding standards, the beach was closed for an estimated total of 23 days in 2003, which was actually not bad considering the amount of rain. There were significantly fewer geese at the beach during the first part of the summer, which may have helped keep bacteria counts down.

At Union Village Dam, the beach continued to have frequent problems meeting standards as it has in other recent years. While elevated bacteria levels are more likely to occur after rainfall, they can also persist during periods of dry weather and the source has not been located despite years of searching. Because of the history of persistence of problems at this project, repeat samples are not always collected right after a bad count is observed, as is normally done at other NAE projects. Following moderate rain, a sample collected on 1 July exceeded standards but the follow-up sample a week later was okay. A sample collected on 22 July after heavy rain exceeded standards, as did all subsequent samples through 13 August; a good sample was not recorded until 18 August. When a sample collected the day after Labor Day also exceeded standards, the beach was closed for the season. Bacteria

counts exceeded standards at this beach for an estimated total of 30 days in 2003, compared to 37 days in 2002. No new information was obtained on the source(s) of these persistent high counts.

West Hill Dam had such frequency of exceedences of criteria during 2001 that a special study of the watershed was performed to try to find the sources, but the beach had far fewer problems in 2002, and this improvement continued into 2003. There were only 3 days in 2003 when samples exceeded beach standards. Following heavy rains over the Memorial Day weekend, a sample collected on 28 May exceeded standards but a repeat on 2 June was okay. Heavy rains caused the park to be closed due to flooding when a sample collected on 24 June exceeded standards, but resampling two days later found acceptable levels. Rain over the Labor Day weekend was the likely cause of a high count on 3 September. Bacteria counts exceeded standards at this beach for an estimated total of 5 days in 2003, compared to 18 days in 2002 and 57 days in 2001.

(2) Beach Closures and 305(b) Reporting. Under section 305(b) of the Clean Water Act, states are encouraged to report, among other things, the frequency of beach closures due to high bacteria counts, with the ultimate hope of showing improvements over time. Possible improvements or degradations in water quality are difficult to discern from annual summaries of beach-monitoring data, in part because of changes in indicator organisms, but mainly because of variations in annual weather patterns. Generally, standards are exceeded only after rainstorms when contamination is washed off yards and streets and into waterways, and the effects are particularly strong at flood control projects. Flood control reservoirs tend to have larger ratios of watershed to water-surface area than do natural lakes or ponds, making them more likely to exceed bacteria standards after a rainstorm. Flood control actions that retain these waters prolong the duration of periods of high bacteria levels. Consequently, annual variations in the number of days that bacteria counts at NAE projects beaches exceed standards are more likely indications of variations in precipitation than changes watershed water quality. This may be the reason that only Connecticut DEP has contacted NAE for this information. Nevertheless, for reference purposes, summaries of beach closures for FY03, FY02, and FY01 are included in table 6.

(3) FY04 Program. In FY04, NAE will begin monitoring the beach at East Brimfield Lake's Holland Pond, which will no longer be monitored by Massachusetts due to budgetary problems. Otherwise, unless New Hampshire changes its regulations in 2004 to require weekly sampling at beaches, no additional changes are likely to NAE's beach monitoring program in FY04.

TABLE 6

SUMMARY OF BATHING BEACH CLOSURES
AT NAE RESERVOIR PROJECTS

Vermont	Locations Monitored	Days Closed* During FY03	Days Closed* During FY02	Days Closed* During FY01
Ball Mountain Lake	1	8	0	2
North Hartland Lake	1	0	0	0
North Springfield Lake	1	0	0	0
Townshend Lake	1	4	0	3
Union Village Dam	1	30	37	29
Total for Vermont	5	42	37	34
New Hampshire				
Edward MacDowell Lake	1	0	3	2
Hopkinton Lake	1	0	0	0
Otter Brook Lake	1	4	0	2
Surry Mountain Lake	1	4	0	0
Total for New Hampshire	4	8	3	4
Massachusetts				
Buffumville Lake	1	2	15	3
Tully Lake	1	0	0	NA
West Hill Dam	1	5	18	57
Total for Massachusetts	3	7	33	60
Connecticut				
Hop Brook Lake	1	49	10	26
Northfield Brook Lake	1	23	8	25
Total for Connecticut	2	72	18	51
Total for the Year	14	129	91	149

*Note that the number of days closed is the total time between the collection of a sample that fails to meet standards and one that passes. At Hop Brook and Northfield Brook Lakes, some of the closures were strictly administrative and there were no bacteria measurements that exceeded standards. Because of the effects of flood control operations on beaches, the total duration of beach closings calculated in this method is a poor indicator of overall water quality. However, it is used by some states in their 305(b) reports.

d. Baseline Fixed Station Monitoring. In order to use resources efficiently, while meeting requirements to monitor water quality trends and changes at Corps projects, NAE splits its baseline water quality program into high and low level monitoring. Briefly, the difference between these two levels is in the statistical certainty of results. High-level baseline monitoring involves a higher level of statistical certainty, and a larger number of samples than low-level monitoring. The NAE Annual Water Quality Report for 1990 contained a detailed explanation of the statistical basis used for selecting sampling frequency for water quality monitoring at NAE projects.

Low-level baseline monitoring was performed in 2003 at the class II and half the class I projects with conservation pools. Baseline data collection was last performed at these class I projects in 2000 and at these class II projects in 2001. Class I projects are those with generally high water quality with no known water quality problems. Only minimal data requirements exist for these projects in order to check for changes and monitor trends. Class II projects are those with only minor water quality problems, and enough data have been collected over the years so that annual monitoring is not required. The class I projects with permanent pools monitored in FY03 include Colebrook River, Hancock Brook, Littleville, Mansfield Hollow, Surry Mountain, and Westville Lakes. The class II projects with conservation pools include Buffumville, East Brimfield Hopkinton, North Hartland, and Tully Lakes. At each project, 2 to 3 stations were sampled three times from April through September at inflow, lake, and discharge stations. Parameters analyzed included field parameters (DO, pH, temperature, conductivity, turbidity), algal nutrients (ammonia, nitrite plus nitrate, total phosphorus), indicator organisms for sanitary contamination (fecal coliforms in Massachusetts and Connecticut, *Escherichia coli* in New Hampshire and Vermont), trace metals, and chlorophyll *a* as a means of assessing lake trophic condition.

High-level baseline monitoring was performed at the class III projects without conservation pools – Birch Hill, Union Village, and West Hill Dams. Baseline data was last collected at these projects in 2001. Samples were collected from inflow and discharge stations six times from April through October. Class III projects are those with continuing water quality problems, and receive more frequent and intensive sampling than class I or II projects. Parameters analyzed included field parameters (DO, pH, temperature, conductivity, turbidity), nutrients (ammonia, nitrite plus nitrate, total phosphorus), indicator organisms (fecal coliforms in Massachusetts, *Escherichia coli* in Vermont) trace metals, and chlorophyll *a* as a means of assessing project trophic conditions.

e. Priority Pollutant Scans.

(1) General. Contaminants are an area of great concern to the Corps nationwide. In response to ETL 1110-2-281 "Reservoir Contaminants," many Corps Divisions have tested for the full range of EPA priority pollutants at all their projects. NAE began performing priority pollutant scans in 1987, when the NAE Lab achieved the ability to analyze organic compounds on the priority pollutant list. Hopkinton Lake and Birch Hill Dam were the initial projects studied. NAE intends to perform at least one scan at all projects eventually. During FY02, priority pollutant scan reports were completed for Knightville Dam and Littleville Lake. Table 7 gives a summary of the status of priority pollutant scans at NAE projects.

(2) Northfield Brook Lake. In FY03 NAE completed a report on a priority pollutant scan at Northfield Brook Lake. As part of a plan for possible aquatic habitat improvement, and NAE's continuing program of priority pollutant scans at all its reservoir projects, sediment samples were collected from Northfield Brook Lake in September 2002 and analyzed for metals, PCB's, pesticides, volatile and semi-volatile organics. Results showed generally low concentrations, indicative of background conditions. Levels of some contaminants were high enough to possibly affect sensitive benthic organisms, but these effects should be minor. No substances were in high enough concentrations to interfere with uses of the project or its waters. However, there is an inconsistency in that SVOC levels reported at the inflow stations were higher than those reported for the lake; usually the reverse is found. This raises questions about how well the samples represent actual conditions in the lake. Consequently, priority should be given to additional monitoring of SVOC's in Northfield Brook Lake sediments. Findings are summarized in "Northfield Brook Lake, Connecticut Priority Pollutant Scans," March 2003.

(3) 2004 Activities. There are seven remaining NAE projects at which priority pollutant scans have not yet been performed. As resources allow, samples from these projects will be collected with the following priority: Surry Mountain, Westville, East Brimfield, Everett, Tully, and Edward MacDowell Lakes, and Blackwater Dam. Surry Mountain Lake has the highest priority due to the presence of the endangered dwarf wedge mussel downstream. Priorities for the other projects are based on recreational usage and general water quality conditions. It is anticipated that no more than two or three projects will be sampled in FY04.

f. West Hill Beach Water Quality Problems. In 2001 Massachusetts went from a fecal coliform to an *E. coli* standard for beaches. Using this new standard, the beach at West Hill Dam in Northbridge began repeatedly failing to meet

TABLE 7

PRIORITY POLLUTANT SCANS
AT NAE RESERVOIR PROJECTS

Project	Report
Connecticut	
Black Rock Lake	Mar 2000
Colebrook River Lake	Sep 1997
Hancock Brook Lake	Mar 2000
Hop Brook Lake	Apr 1993
Mansfield Hollow Lake	Sep 2000
Northfield Brook Lake	Jul 1992
Thomaston Dam	Aug 1994
West Thompson Lake	Dec 1994
Massachusetts	
Barre Falls Dam	Jul 1995
Birch Hill Dam	Jul 1988
Buffumville Lake	Jan 1999
Conant Brook Dam	Apr 2000
Hodges Village Dam	Jan 1999
Knightville Dam	Apr 2002
Littleville Lake	Apr 2002
West Hill Dam	Apr 1999
New Hampshire	
Franklin Falls Dam	Nov 2000
Hopkinton Lake	Jun 1988
Otter Brook Lake	Feb 1993
Vermont	
Ball Mountain Lake	Jun 1998
North Hartland Lake	Jun 1998
North Springfield Lake	Jun 1998
Townshend Lake	Jun 1998

acceptable levels. Whether this was due to a coincidental change in the watershed, the new *E. coli* standard detecting problems that were previously missed, or problems with labs performing the new test is not clear. The frequency of problems prompted NAE to begin intensively sampling in the upstream watershed to try to find a source or sources that might be correctable.

Watershed investigation and analysis of data collected in 2001 found some likely contributing sources but was unable to identify a source or sources remediation of which would definitely solve the problem. There was a horse whose pasture was subject to frequent flooding; getting the owner to move the horse helped reduce bacteria levels but by an unknown amount.

NAE was planning to continue watershed sampling and combine it with experimental DNA source identification, but conditions at the West Hill Dam beach during the 2002 recreation season were significantly improved over 2001. How much this was due to drought, watershed improvements prompted by NAE, or other factors, is unknown. Although 2003 had a wetter spring and summer than 2002, the frequency of elevated bacteria counts continued to drop.

NAE is still waiting for the results of DNA testing of samples by the Wall Experiment Station, work that could help identify sources. The most recent sampling was from the fall of 2002 and may not reflect current watershed conditions when the data are finally received.

EPA funded a sanitary survey of the West Hill Park Beach in July 2003. It relied heavily on data collected by NAE, and was unable to identify any potential sources of high bacteria that were not previously identified by NAE.

NAE will monitor the beach as usual in FY04, but if persistent problems reemerge, additional watershed sampling and possible DNA analyses will be undertaken.

g. Fish Kill at Deweys Mills Pond. In the spring of 2003, melting ice revealed dozens of dead fish in one area of Deweys Mills Pond, an impoundment just upstream of the main pool at the Corps North Hartland Lake project. Some of the fish were good sized including largemouth bass over 20 inches long, as well as many smaller fish. An investigation by NAE concluded that the fish kill was caused by oxygen depletion under the ice. The winter of 2002-03 was relatively severe and caused an extensive ice cover on Deweys Mills Pond that lasted longer than usual. The highly eutrophic condition of the pond caused low DO levels even during the

summer daylight hours. During the winter, the gradual decay of organic material under the ice in this shallow pond used up the DO, and the limited exchange of water between the pond and the Ottauquechee River was unable to replenish the DO or enable many of the fish to find an escape route.

In June the Vermont Department of Fish and Wildlife electro-fished the lake to assess the effects of the winterkill. Results for largemouth bass and northern pike in 2003 were compared to findings in 2002 and 1990. While catch rates for largemouth bass and northern pike were lower in 2003 than 2002, the differences were within normal sampling variations observed in other ponds. It was not claimed that the fish kill had no effect on the largemouth bass population, but survey results did not show cause for alarm. As size classes from 5 to 16 inches were observed, the bass population was expected to recover quickly in line with available habitat.

h. Fishery Work at Ball Mountain and Townshend Lakes. The park rangers need current information on the condition of the fisheries at Ball Mountain and Townshend Lakes in order to manage them effectively. In addition, the project manager is considering eliminating the permanent pool at Ball Mountain Lake and needs information to evaluate the effects of such a change. Starting at Ball Mountain Lake in late July and continuing at Ball Mountain and Townshend Lakes in August and September, inflows, major tributaries, lake stations, and discharges were sampled for fish populations and water quality parameters. Preliminary data at Ball Mountain Lake indicated the presence of a small forage fish population, but only one largemouth bass was collected. A quick comparison with data collected in 1986 shows a significant decline in diversity and numbers. Fathometer readings indicated significant numbers of fish at a depth of 25 to 35 feet, especially hanging along the ledges adjacent to the north shore. These were likely salmonids as the temperature and DO measurements showed favorable conditions for them at that depth; however, we were unable to confirm that as electro-fishing is unable to sample at that depth and gill netting for an hour did not collect any fish.

Townshend Lake was electro-fished in August and September, which was the first time it had been done at this project. A respectable diversity of fish was found, including the surprise of finding a species of killifish (*Fundulus*). The primary game fish was small mouth bass. Lack of cover limits fish productivity at Townshend Lake. A report on findings at Ball Mountain and Townshend Lakes is scheduled for completion in FY04.

i. Fishery Work at Tully Lake. Objectives for this study were to determine the condition of the fishery in comparison to data generated in the extensive survey

completed in the early 1990's, and determine the effect of the draw down of the pool in May 2001 for dam repairs on that year's age-class of fish. Park rangers also wanted to know what the effects of a proposed 44-house development at the south end of the lake might have on the project's fishery and water quality; however, too little information on the details of that development were available to allow such an evaluation. Previous data indicated dissolved oxygen levels in the lake below about 4 feet were too low to support a healthy fish population. Data from 1993 showed very few young of the year largemouth bass, which may have been a consequence of over fishing or chemical or physical conditions in the lake. The 2003 study involved lake profiles, fish sampling by electro-shocking with emphasis on determining the age-classes of largemouth bass, and study of data from creel surveys. Project rangers began collecting creel-survey data in 2001.

Sampling in 2003 revealed a fishery that seems to have improved since the 1993. Recreational use of the lake has also increased greatly since the early 1990's. There was increased filamentous alga and rooted macrophytes in the lake, indicating an increase in nutrient inflow, and the profile data indicates the same low-to-non-existent dissolved oxygen below about 6 feet as had been previously observed. This increase in nutrients may also be the engine fueling the food chain leading to an improved fishery. The water quality issues become more relevant in light of the extensive development planned on the upland adjacent to the lake. A final report on results is scheduled for completion in FY04.

j. North Hartland Lake, Deweys Mills Pond Studies. In July NAE produced a summary report on the condition of North Hartland Lake's Deweys Mill Pond, a highly eutrophic sub-impoundment upstream of the project's conservation pool. Deweys Mill Pond has the potential to be a superb recreational area. It is within easy walking distance from the village and the proposed new visitors center, and offers access to the Ottauquechee River and to the Quechee Gorge. However, the pond is little used during the summer months because dense growths of rooted and floating aquatic plants making boating or fishing difficult to impossible. Fishery and water quality data collected in 2001 and 2002, and continuing into 2003, indicate there has been a dramatic improvement in the largemouth bass population in the past decade, but that water quality conditions are deteriorating and may be an obstacle to maintaining this fishery. This was dramatically illustrated during a fish kill last winter that was apparently caused by depletion of dissolved oxygen due to decaying vegetation beneath the ice. If no actions are taken, silt accumulation and aquatic plant growth will continue to increase and water quality and recreational opportunities will continue to deteriorate.

The study recommends that selective dredging of accumulated organic material be considered as part of a management plan for the pond. Some of the dredged material could be placed on the central island for greater shrub and tree growth, which would provide more waterfowl roosting and nesting habitat. The remainder of the dredged material could be dewatered and disposed of off site; chemical analyses have not found contamination in the sediment that would limit disposal options. Shallow areas of aquatic macrophytes should remain to provide cover for young of the year fish and shallow shelf areas preserved along the shore to be used for fish nesting areas. There should be a replacement of the single outflow culvert with an adjustable structure to allow greater flow regulation as well as the ability to release water from the bottom.

k. Water Quality Evaluation Updates. The first comprehensive assessments of water quality conditions at NAE projects were completed in the early 1980's after the major municipal WWTP's, funded under the Clean Water Act, were completed. Although changes in water quality conditions at most projects have been relatively minor since then, a lot of additional data has been collected since then, watershed conditions had changed, analytical conditions have improved, and these reports were seriously out of date. In FY03 Water Management Section began updating these reports to include the latest data and results of water quality, fisheries, and biological studies at these projects. Updated evaluations were completed for Barre Falls Dam, and Hop Brook and Buffumville Lakes.

l. Silt Discharge into Northfield Brook Lake. In FY03 there were a couple of times when work on an upstream dam resulted in sediment discharges to Northfield Brook Lake. Work on Knife Shop Pond Dam, which is about a half mile upstream from the Corps project boundary, required lowering the pond. When it was emptied, sediment and some large fish washed into Northfield Brook Lake; in late May, a woman caught a very large bullhorn there. During an early June storm, a retention pond at the upstream worksite was lost and sediment – mostly gray silt – washed down into the lake. Much of the beach and lawn, and portions of the access road were coated with a layer of dried mud. On the whole, however, work at Knife Shop Dam appeared to have improved conditions at Northfield Brook Lake by drawing off large numbers of Canada geese that normally infest and befoul the beach and adjacent lawn areas.

m. Water Milfoil Treatment at Hopkinton Lake's Elm Brook Pool. When the invasive aquatic weed *Myriophyllum spicatum*, commonly known as "Eurasian water-milfoil," becomes established in a lake, it can cause serious problems including overwhelming existing plants, filling shallow areas to the depth of sunlight pene-

tration, interfering with recreation, and degrading fish and wildlife habitat. In recent years it has been causing increasing problems at Hopkinton Lake's Elm Brook Park. Boat propellers were getting tangled, the weeds were interfering with fishing, and park rangers were concerned that it was harming the fisheries' habitat. Consultations with the state of New Hampshire convinced the Merrimack River Basin Environmental Compliance Coordinator (ECC) that the best course of action was to treat portions of the lake with herbicides. After obtaining the proper permits, contacting abutters, and confirming that there were no wells within 200 feet of the lake, the ECC contracted to have the 100 worst acres treated with the herbicide 2-4 D. The contract was won by a company that also has a good reputation with the state of New Hampshire. The herbicide was applied in the form of dry pellets from a boat in one day.

During treatment, the lake was heavily posted and closed to fishing for one day and to swimming for a week. Results were very successful and no significant reoccurrence of the milfoil was noticed in the treated areas by the end of the year. Fishermen were particularly pleased with the improved condition of the lake. It took about 3 weeks for the weeds in the treated areas to die completely. Dead vegetation apparently sank to the bottom of the lake because it did not significantly pile up on the shore. There were no fish kills and the only problem was some burning of lily pad leaves. The ECC instructed the contractor to try to protect the lily pads; however, the milfoil was growing amongst the pads and it was not possible to keep them from harm entirely.

It cost about $20,000 to treat 100 acres. Next year they plan to treat another 50 acres including areas closer to the beach, which could mean they will have to close the beach for 10 days. After that they plan to monitor annually. Typically, these treatments last about 5 years. The project will never be free of milfoil, but controlled herbicide treatments can go a long way to help manage the problem.

n. FY03 Reservoir Water Quality Concerns. NAE rated water quality at most of its reservoirs during FY03 as good to excellent, because it usually met State standards and was usable for its intended purposes. External phenomena including acid rain, urban runoff, wastewater treatment plant discharges, and natural watershed conditions were primary causes of water quality concerns. Corps project operations do not adversely affect water quality at any NAE reservoirs.

Table 8, a summary of water quality concerns at NAE projects in FY03, shows many projects with high levels of metals, color, nutrients, turbidity, and bacteria; and low levels of pH and DO. However, some things need explaining lest this

TABLE 8

NAE RESERVOIR WATER QUALITY CONCERNS FY03

Project	Low pH	High pH	Low DO	High P	High N	High Color	High Turbidity	High Bacteria	High Metals	Other Concerns	Suspected Contributing Sources
Ball Mountain, VT										Sediment	Loss of minimum pool
Birch Hill, MA	X		X					X	Hg,Al	PCBs, Fish advisory	WWTP discharges, Acid rain
Buffumville, MA	X	X	X	X						Aquatic weeds	WWTP discharges, Acid rain
East Brimfield, MA	X	X	X	X					Hg	Aquatic weeds, Fish advisory	Swamps & marshes, Acid rain
Hop Brook, CT	X	X	X	X	X	X	X	X	Al,Hg	Algae blooms	Urban runoff, Farm runoff, Acid rain
Hopkinton, NH	X		X						Zn	Aquatic weeds	WWTP discharges, Acid rain
Mansfield Hollow, CT								X			Unknown sources to Fenton R.
Northfield Brk, CT	X			X	X			X	Hg	Algae blooms	Acid rain
North Hartland, VT		X		X	X		X		Hg,Al	Aquatic weeds	WWTP discharges
Thomaston, CT									Hg, Pb, Al		WWTP discharges, Acid rain, Urban runoff
Tully, MA	X		X			X			Hg	Tannic acids	Swamps and marshes
Union Village, VT							X	X	Hg,Cd,Cu, Zn,Al,Fe	Acid mine drainage	Abandoned copper mines, Farm runoff
West Hill, MA			X					X			Urban runoff
West Thompson, CT	X	X	X	X	X	X	X	X	Hg,Al, Pb	Algae blooms,	WWTP discharges, Acid rain

table presents an unrealistically bad impression of water quality conditions. What the table lists are water quality concerns – these are not necessarily all problems. For example, most metals listed have been found only rarely at levels above criteria necessary to protect aquatic life. Furthermore, these criteria were taken from the literature, not studies of project conditions and resident aquatic life. Only at Union Village Dam, Vermont, is there evidence of metals adversely affecting aquatic life, and the effects appear minor. Metals at Union Village Dam originate in acid mine drainage from abandoned copper mines upstream from Corps project boundaries. At the remaining NAE projects, metals appear to be the result of upstream wastewater discharges, or natural watershed conditions and effects of acid rain. Mercury is a concern at all NAE projects; however, mercury contamination of fish is a problem for all New England States, and large sections of the rest of the country. The widespread nature of the mercury problem is generally believed due to atmospheric deposition. Most color, iron, manganese, and some low pH levels originate in swamps and marshes in the watersheds. Acid rain is suspected of being responsible for very low pH levels. High nutrient levels originate primarily in agricultural runoff and wastewater treatment plant discharges. Erosion in watersheds, and algal blooms in reservoirs, are sources of high turbidity at NAE projects. Urban runoff, wastewater treatment plant discharges, and agricultural runoff produce high coliform bacteria counts. Low DO levels are due to natural watershed conditions and excessive algae and aquatic macrophyte growth.

o. Coordination with Other Agencies. NAE tries to coordinate its water quality program with the states and other interests; most of this coordination occurs through informal contacts. Results of drinking water analyses are sent to the appropriate State agencies within the prescribed timeframes. Beach analyses at New Hampshire projects are sent to the New Hampshire Department of Environmental Services monthly. In Massachusetts, results from the beaches at Buffumville Lake, Tully Lake, and West Hill Dam are sent to the Charlton, Tully, and Uxbridge Boards of Health (BOH), respectively. These BOH officials also requested that, when counts exceed standards, we telephone results directly to them. Beach data from projects in Connecticut are sent to the Department of Environmental Protection annually for inclusion in their 305(b) report.

p. Data Management Systems. NAE currently stores water quality data in Microsoft Access. Initially, data had been stored on the Laboratory Information Management System (LIMS), and transferred to users in PC-compatible spreadsheets. In FY99 NAE purchased GIS\Key software for storing, retrieving, and analyzing water quality (and HTW) data. Use of GIS\Key began in FY00, but was discontinued at the end of the year because of the expense and the possible adoption of

a Corps-wide system. We had expected that DASLER would be accepted as the Corps standard, but we were watching NWD to see what system they would adopt. The National Marine Fisheries Service wrote a Biological Opinion on the Columbia River that requires the Action Agencies, including NWD, to have a "common regional database for fish, fish habitat and water quality." A committee headed by Laura Hamilton was evaluating different systems, and there was a good chance that what they selected would become the standard for many other agencies including other Corps Divisions, especially if they selected DASLER. However, in October 2002 we learned that they had selected SEDQUAL. We are currently waiting to see how other Corps offices react to this selection. In the meantime, Microsoft Access meets our immediate data storage and retrieval needs, and Access data can easily be transferred to SEDQUAL or DASLER, so we are not losing time or wasting effort by waiting.

4. CONTINUING WATER QUALITY CONCERNS

a. General. This section discusses continuing water quality concerns at specific projects, and general concerns including algal blooms, fish-consumption advisories applicable to NAE projects, and Canada geese. Also included is a discussion of state 303(d) listings that include stream sections within NAE projects. This manner of presentation means that the same water quality concern may be discussed more than once or even multiple times, but it can make for a more convenient method for evaluating them.

b. Specific Projects. There are six reservoir projects, operated and maintained by NAE, that have continuing water quality problems: Hop Brook, Northfield Brook, and West Thompson Lakes in Connecticut, Birch Hill and West Hill Dams in Massachusetts, and Union Village Dam in Vermont. This section summarizes the problems, and how NAE is addressing them.

(1) Hop Brook Lake. This project has chronic high bacteria counts and algae blooms, causing the popular beach to be closed to swimming often. These problems originate in land-use practices outside the borders of Hop Brook Lake. Consequently, NAE has tried to involve State and local agencies in taking actions such as checking for failing septic systems, and helping farmers use good agricultural practices. Additionally, NAE is designing sedimentation basins on tributary streams to intercept suspended sediment containing the phosphorus that fuels algae blooms. Finally, because lake bacteria counts tend to rise after heavy rains, the relationship between runoff and bacteria levels has been studied, and protocols developed to maximize the amount of time the lake can safely be open. FY03 was a

fairly typical year at this project for beach closures due to elevated bacteria counts, but there were no nuisance algal blooms.

(2) Northfield Brook Lake. Bacteria counts at the popular beach at this small project tend to rise and fall quickly when it rains. Consultations with the local health department have indicated that the problem is not due to any particular source, but from the watershed in general, which is small, hilly, and generates runoff quickly when it rains. After studying the relationship between rainfall and beach bacteria counts, NAE developed and tested a beach closure protocol based on rainfall. The 2003 season was fairly typical for the total number of beach closings, but considering the amount of rain, it may have had fewer high bacteria counts than usual due to the fewer numbers of geese during the recreation season.

(3) West Thompson Lake. This lake has severe annual algae blooms that look nasty and disrupt its ecosystem. NAE is continuing to gather data on sources of the excess phosphorus fueling these blooms. Blooms were not any lighter than usual in 2003 despite the extra rain, and were heavier than usual in the fall.

(4) Birch Hill Dam. Sediments at this project are contaminated with PCBs. After more than a decade of studying the problem and discussing it with the state and EPA, NAE has developed a PCB monitoring plan, based on reservoir flood frequency and elevation, that is incorporated into the operation of Birch Hill Dam. Under this protocol, an initial sampling of 15 public access points was performed in FY02. All were below the threshold for further action, which was 10 ppm in soil and 2 ppm in sediment as given in the state's action limits. Although precipitation was above average in 2003, water levels did not get high enough to trigger sampling. If an exceedence is found during future monitoring, the Corps will take action to restrict public exposure, such as posting the area or closing a beach as necessary.

(5) Union Village Dam. Acid mine drainage from abandoned copper mines interferes with benthic habitat and colors the river red during high runoff events. As the mines are not on Corps property, NAE has no control over them, but when possible through programs of technical assistance to the States, NAE has studied the mine drainage problems and outlined methods to stabilize the tailings piles which cause most of the problems. However, due to the complexity of the site and the potentially hazardous and toxic materials involved, EPA is looking at the site under the Superfund program.

The beach at Union Village Dam has had chronic problems with elevated bacteria counts that have caused frequent closures. NAE has been working with the

state health department to try to find the source of these bacteria. We thought we had some initial success when watershed sampling traced some high counts to a pasture where the animals had direct access to a stream. However, after the stream was fenced off and the counts from that tributary dropped, the beach continued to record frequent high numbers. Although counts are likely to be higher after a rainstorm, they can also be high during drier weather. Because of the high cost of collecting additional samples in this distant watershed, NAE is currently relying on the Vermont department of health to try to find the source or sources of the problem. Beach closures due to elevated bacteria counts continued to be high in 2003.

(6) West Hill Dam. The beach at West Hill Dam frequently had high bacteria counts during FY01 (see paragraph 3.f). NAE was planning to continue watershed sampling and combine it with experimental DNA source identification, but conditions at the West Hill Dam beach during the 2002 and 2003 recreation seasons were significantly improved over 2001. How much this was due watershed improvements prompted by NAE or other factors is unknown. NAE will monitor the beach as usual in FY04, but if persistent problems reemerge, additional watershed sampling and DNA analyses will likely be undertaken.

c. Algal Blooms. There are 3 NAE projects with histories of algal blooms – West Thompson, Hop Brook, and Northfield Brook Lakes, all of which are in Connecticut. For NAE overall, algal blooms were relatively light in 2003, probably due to the cool conditions and the flushing caused by spring and late summer rains.

(1) West Thompson Lake. This project has long been plagued with severe algal blooms that generally begin in July turning the water green and forming dense slicks on the surface. Typically the blooms start with diatoms, then progress to green algae, and finally culminate in heavy growths of blue-green algae, often *Anacystis*. Upstream WWTP discharges, believed to be the source of the excess nutrients fueling these blooms, have been gradually upgrading their systems including nitrogen and phosphorus removal in recent years. As a consequence, water quality conditions have been gradually improving. During FY03 algal blooms were fairly typical despite the cool conditions and flushing caused by spring and late summer rains. However, in mid-September there was a heavier bloom than is usually seen at that time of year.

(2) Hop Brook Lake. This project has had varying degrees of problems with algal blooms over the years. The lake usually has a strong algae population that may border on bloom conditions but tends to be dispersed and not cause problems. However, some years slicks form, and in the worst years the bloom can be so heavy

as to give the appearance that the lake was drained and refilled with green paint. In recent years blooms have generally not been much of a problem. At various times during the summer of 2003 there were reports of green mats or clumps of algae forming, especially on the lake bottom, but no real bloom conditions developed.

(3) Northfield Brook Lake. This project does not have a history of severe blooms, but has had occasional nuisance blooms. There were no algae problems in 2003.

d. Fish Advisories. All NAE projects are included in some type of advisory on consumption of fish caught there, but none of these advisories are due to Corps activities, rather they are due to factors such as contaminated sediments or atmospheric deposition. Mercury is a particular problem, and there are statewide advisories for freshwater fish in all New England states except Rhode Island. This is part of a national problem, because the mercury originates in incinerators and coal-burning power plants and comes down with atmospheric deposition. In wetlands, the deposited inorganic mercury is microbiologically converted under anaerobic conditions to organic mercury, which is mobile in water and bioaccumulates in fish.

(1) Connecticut. Due to mercury contamination, there is a statewide advisory recommending that the general public limit consumption of all species except trout to no more than two meals per month. In addition, the advisory recommends that pregnant women, women planning to become pregnant within one year, and children under the age of 6 limit consumption of trout more than 15 inches in length to no more than two meals per month. There are no specific advisories for fish from the waters of any NAE projects in this state.

(2) Massachusetts. In Massachusetts, mercury contamination has prompted a statewide advisory recommending that pregnant women not consume freshwater fish caught in any river or lake. In addition there are the specific advisories affecting the following NAE projects.

Buffumville Lake. Due to mercury contamination, children under 12 and pregnant and nursing mothers should refrain from eating all species, and the general public should limit consumption to no more than 2 meals per month. This advisory for Buffumville Lake was new in 2002; in prior years there was no specific advisory for this lake.

Charles River Natural Valley Storage Project. The sections between the South Natick Dam and the Charles River Basin have an advisory for PCB and

pesticide contamination in carp and largemouth bass. This recommendation is that the general population limit consumption of largemouth bass to two meals per month, and that children under 12 and pregnant and nursing mothers not eat any; and that all persons should not consume carp from these waters. The concerns about pesticides and the addition of largemouth bass were new to the fish advisories list for 2002. Between the South Natick and Medway Dams, the recommendation is that the general population limit consumption of largemouth bass to two meals per month, and that children under 12 and pregnant and nursing mothers not eat any due to mercury contamination.

Birch Hill Dam. Due to PCB contamination there is an advisory that children under 12 and pregnant and nursing mothers not eat any fish and that all persons refrain from eating white sucker or brown bullhead taken from the Otter River within ½ mile of its confluence with the Millers. For the Millers River, there are advisories from Erving to Winchendon, which includes the length of the river within the Birch Hill Dam project area. Based on mercury and PCB contamination, children under 12 and pregnant and nursing mothers should refrain from eating all species, and the general public should refrain from eating brook trout and American eel, and limit consumption of all other species to no more than two meals per month. For largemouth bass caught in Lake Dennison, there is an advisory based on mercury contamination that children under 12 and pregnant and nursing mothers not eat any and the general population limit consumption to two meals per month.

East Brimfield Lake. For the Quinebaug River including East Brimfield Lake and Holland Pond, there is an advisory based on mercury contamination. It recommends that children under 12 and pregnant and nursing mothers refrain from eating all species, and the general public limit consumption of all species to no more than two meals per month.

(3) New Hampshire. Due to mercury contamination, there is a statewide advisory recommending that the general public limit consumption of all species to no more than four 8-ounce meals per month, and refrain from eating any pickerel or large or smallmouth bass more than 12 inches in length. This advisory further recommends that pregnant and nursing mothers, and women who may get pregnant consume not more than one 8-ounce meal per month, and children under 7 not consume more than 1 3-ounce meal per month of freshwater fish. There are no specific advisories for fish from the waters of any NAE projects in this state.

(4) Vermont. Due to mercury contamination, there are statewide advisories recommending varying limits on consumption of different fish species other

than brown bullhead and pumpkinseed-sunfish for which there are no recommended restrictions. These advisories are for the general population and a high-risk sub-population that includes pregnant and nursing mothers, women who may get pregnant, and children under 6. Walleye are considered the most contaminated and the advisory recommends the general population restrict consumption to no more than one meal per month and high-risk women and children avoid them entirely. The general population should eat no more than 3 meals per month of lake trout, smallmouth bass, chain pickerel, or American eel; and high-risk women and children should have no more than 1 meal per month of any of these. For largemouth bass and northern pike, general population should eat no more than 6 meals per month, and high-risk women and children should have no more than 2. There is no recommended limit for the general public on consumption of trout or yellow perch, but high-risk women and children should limit consumption of these to no more than 3 to 4 meals per month. For all other freshwater fish species caught in Vermont, the general public should limit consumption to no more than 9 meals per month, and high-risk women and children to no more than 2 to 3 meals per month. There are no specific advisories for fish from the waters of any NAE projects in this state.

e. Canada Geese at NAE Projects During FY03. Flocks of Canada geese can be a serious nuisance in areas where they congregate in large numbers, and their flocks have increased dramatically over the past two decades. Often attracted to areas with fields of mown grass near small lakes with aquatic weed beds, their droppings are the biggest problem and can carpet an area making it quite unattractive. Additionally, the droppings can contaminate the water adding nutrients and bacteria. During FY03, as in past years, the project with the largest number of geese in the vicinity of its beach was Hop Brook Lake. Buffumville, Northfield Brook and Townshend Lakes and West Hill Dam also had geese congregating in large numbers near their beaches. There were also some geese on or near the beaches at Edward MacDowell, Hopkinton, North Springfield, and Otter Brook Lakes, but these caused no more than minor problems.

A variety of approaches were used to deal with the problems caused by the geese. Buffumville Lake used a border collie to keep them from the beach. East Brimfield Lake found that a coyote decoy would scare the geese from landing near the beach provided the decoy was moved at least every 6 hours. The rangers at Townshend Lake cleaned goose droppings from the beach at the start of the day. Northfield Brook Lake obtained a depredation permit from the USFWS, but didn't need it because the numbers of geese at the project were much fewer in FY03 than previous years.

Hop Brook Lake had the most active goose-control program. In 2002 they obtained a depredation permit from the U.S. Fish and Wildlife Service that allowed them to take up to 20 per year, but they only took 15 and that was set as the limit on their 2003 permit. They began scaring geese in January when the ice cleared and the birds started to arrive. Using shotguns, park rangers would fire special shells that explode like firecrackers over the heads of the geese.

By spring, when scare tactics began just causing the birds to move to another part of the beach, rangers began taking birds under their permit, which allows the culling of no more than 2 birds per day, but no limit per month provided the annual total was not exceeded. They went for the lead birds, which are identified as those that honk at you when you approach. The theory was that these were the birds that led the flock to this beach, and the new lead birds might take them elsewhere. They took 2 birds in May, 3 in June, and another 2 in July. Despite these tactics, flocks of 30 to 40 geese were common around the beach, and 54 geese were counted there on one visit in late July. In August the rangers became more aggressive and took 6 geese, and that – or some other unknown factor – resulted in a drop in the numbers of geese recorded during the beach sampling runs to about 10 to 20. In September the rangers took the last 2 geese allowed under their 2003 permit, at which point they had to use only non-lethal harassment. Dead birds were buried on project lands deep enough that they would not be dug up by coyotes. The project manager will request that the limit on the permit be raised to 20 geese for 2004.

Geese were less of a problem at Northfield Brook Lake in FY03 than in recent years. There were a lot fewer of the birds, the beach was much cleaner, and there were fewer high bacteria counts than usual over the past few years. Park rangers said that pond at the upstream Knife Shop Dam was lowered to allow work on the dam, and this created a large area of new vegetation that geese apparently found more attractive than the lawns around the Northfield Brook Lake beach.

f. 303(d) Listings. Section 303(d) of the Clean Water Act requires States to list all waters that are not expected to achieve their designated use goals even after all appropriate and required water pollution control technologies have been applied. Waters that are presently not meeting fishable/swimmable goals, for example, because of point-source discharges that are not complying with their effluent limits, are not included on the 303(d) list. Those waters are expected to achieve water quality goals when the State takes compliance actions against the dischargers. However, waterbodies that do not or are not expected to meet water quality standards after all point-source discharges are achieving appropriate treatment must be included on the 303(d) list of impaired waters. The 303(d) list includes the reason for impairment,

which may be one or more point sources such as industrial or sewage discharges, or nonpoint sources such as urban or agricultural runoff.

States are generally required to submit their 303(d) list in April of even-numbered years. The most recent information located for Connecticut and Vermont was from 2002, but from Massachusetts and New Hampshire was from 1998. The following is a summary of NAE projects situated on waters that are included in the most recent 303(d) lists. It should be noted that in some cases the amount of sampling involved was as little as one sample taken during a period that represent neither worst-case nor typical conditions. Consequently, a 303(d) listing should not be considered definitive proof that a problem exists nor should the absence of a parameter mean it is not a problem. Additionally, in some cases the listing of a parameter may be based on sampling by NAE, so the Corps should try not get caught in a feedback loop of assuming a problem exists because the state listed it, when the state listing may have been based on an NAE report.

(1) Connecticut. Parts of four NAE projects are on Connecticut's list: Hop Brook, Northfield Brook, West Thompson, and Mansfield Hollow Lakes. Eutrophication is the problem at most of these, and priority for TMDL development to deal with these problems is low.

West Thompson Lake is on the list for eutrophication and aesthetics, which are both related to chronic algal blooms. Sources are given as POTW's and agricultural nonpoint sources. Northfield Brook Lake is on the list for eutrophication and contact recreation because of excess nutrients and bacteria contributed by nonpoint sources. Hop Brook Lake is on the list for eutrophication and contact recreation because of excess nutrients and bacteria contributed by stormwater, failed septic systems, and agriculture. The Natchaug River from its headwaters to Basset Bridge Road at the entrance to the main part of the Mansfield Hollow Lake conservation pool is on the list for indicator bacteria levels that do not support primary contact recreation; the source of these bacteria has not been identified.

(2) Massachusetts. Parts of six NAE projects are on Massachusetts' list: Birch Hill Dam, Buffumville Lake, the Charles River Natural Valley Storage project, East Brimfield Lake, Tully Lake, and West Hill Dam. No indication is given as to when TMDL's might be developed to deal with these problems.

Birch Hill Dam has 4 bodies of water that are on the 303(d) list: the Millers River, Otter River, Priest Brook and Lake Dennison. The main concern is "priority organics," i.e. PCB contamination in the sediments from past, unidentified up-

stream sources. The Millers and Otter Rivers are also listed for metals, pathogens, and nutrients; and the Otter River is further listed for habitat alterations, organic enrichment/low dissolved oxygen, and salinity/ TDS/chlorides. Priest Brook is listed for metals as well as priority organics. Lake Dennison is not listed for priority organics but only for organic enrichment/low DO.

After more than a decade of studying the problem and discussing it with the state and EPA, NAE has developed a PCB monitoring plan, based on reservoir flood frequency and elevation, that is incorporated into the operation of Birch Hill Dam. Under this protocol, an initial sampling of 15 public access points was performed in FY02. All were below the threshold for further action, which was 10 ppm in soil and 2 ppm in sediment. These levels were taken from the state's action limits. If an exceedence is found during future monitoring, the Corps will take action to restrict public exposure, such as posting the area or closing a beach as necessary.

Buffumville Lake is listed for noxious aquatic plants. In April 2002 the Massachusetts DEP issued a draft TMDL for phosphorus for selected French River basin lakes including Buffumville. The estimated annual loading of total phosphorus to Buffumville Lake in this report is 1250 Kg per year and the target loading is 860. To achieve this the report recommends public education, a watershed survey, a lake management plan, forest best management practices (BMP's), and residential and highway BMP's. The report notes that in most cases, authority to regulate non-point source pollution and thus successful implementation of a TMDL is limited to local government entities and requires cooperative support from local volunteers, lake and watershed associations, and local government officials. Hodges Village Dam hosted a public meeting on the draft TMDL report in April 2002. After receiving public comments, DEP modified the report and sent it to EPA for approval.

East Brimfield Lake including Holland Pond is also listed for noxious aquatic plants, but this lake was not included in the Massachusetts Clean Lakes Programs Projects, and priority for TMDL development is low. Portions of the Charles River Natural Valley Storage project are on the 303(d) list for a variety of pollutants including pathogens, nutrients, and metals. The East Branch of the Tully River including its length through the Tully Lake project area is on the list for metals and priority organics. Possible sources are not given.

The last 8.8 miles of the West River, including the segment that flows through West Hill Dam, are listed for salinity/TDS/chlorides, organic enrichment/ low dissolved oxygen, pH, nutrients, and metals. However, this appears to be based on limited sampling that did not show large exceedences of criteria.

(3) New Hampshire. The Contoocook River, for about a one-mile stretch within upstream limits of the Hopkinton Lake project area, is the only body of water within the limits of an NAE project that is on New Hampshire's 303(d) list. It is listed for zinc, and although the source is unknown, the priority for TMDL development to deal with this problem is given as high.

(4) Vermont. Parts of three NAE projects are on Vermont's list: Ball Mountain and Townshend Lakes, and Union Village Dam. Priorities for developing TMDL's to deal with these problems are low, but acid-mine drainage at Union Village Dam is being examined through the Superfund program.

The West River between Ball Mountain and Townshend Lakes is listed for sediment. The priority for TMDL development to deal with this problem is low, and no potential sources of impairment are listed; however, problems with a gate at Ball Mountain Lake dam have allowed large amounts of sediment to be flushed into the river in the past. As part of a program to restore Atlantic salmon runs to the West River, the pool at Ball Mountain is kept at the 25-foot stage in the spring to facilitate downstream migration. Because the watershed is flashy and the reservoir valley is steep at this low pool level, it is very difficult to maintain the 25-foot pool. However, if something goes wrong and the pool drops much below 25 feet, large amounts of the accumulated sediment behind the dam can be mobilized and washed downstream. NAE has installed an automatic gate control mechanism and is continuing to look at means to improve system reliability.

At Union Village Dam, the Ompompanoosuc River from Sawnee Bean Brook to the Corps beach area is on the list for pathogens. It is likely that Corps monitoring of the beach and attempts to involve the local and state authorities in the search for the sources of these pathogens is what alerted Vermont to the problem and got this section of river on the 303(d) list. The priority for TMDL development to deal with this problem is low.

The West Branch of the Ompompanoosuc River, including its full length through the Union Village Dam project area, is on the list for metals and pH, due to runoff from the abandoned Elizabeth mine. Cleanup of the Elizabeth mine is now being studied under the Superfund program.

g. Aquatic Weeds. Aquatic macrophytes, as opposed to algae, are chronic problems at four NAE projects: Buffumville, East Brimfield, Hopkinton, and North Hartland Lakes. These are all longstanding problems, although they have gotten noticeably worse at Hopkinton and North Hartland Lakes in recent years.

(1) Buffumville Lake. Aquatic weed growth, predominately Myriophyllum (water-milfoil) and *M. heterophyllum*, have been a serious problem in the lake, and it is in the Massachusetts 303(d) list for noxious aquatic plants. Excessive weed growth is encouraged by the shallowness of the conservation pool, availability of plant nutrients, and fertility of the unstripped bottom of the conservation pool, which was formerly agricultural land. Prolific growth of these undesirable weeds interferes with boating, swimming, and fishing. In addition, these plants at best provide only marginal benefits as food for ducks and other wildlife. The herbicide Silvex was used in the 1970's with some success, but the last treatment was in 1979. There have been no attempts in recent years to control the weed growth.

(2) East Brimfield Lake. Excessive aquatic weed growth is a serious problem in the East Brimfield Lake conservation pool, affecting swimming at the beach and boating in the entire lake, and the project is included in the Massachusetts 303(d) list for noxious aquatic plants. A combination of factors likely produced and aggravated the situation. Because the pool is quite shallow, sunlight can penetrate to the bottom of most of the impoundment; lake-bottom soils are rich in nutrients because much of the reservoir is underlain by fertile land that was productive in agriculture prior to flooding; quiescent conditions in the pool contribute to a suitable aquatic environment for weed growth; and the Quinebaug River brings in additional nutrients.

The primary nuisance weed was identified in the 1980's as the water-milfoil, *Myriophyllum heterophyllum*. This bottom-attached weed is very difficult to control mechanically because the stems are weak and break easily, leaving the root system intact in the bottom sediments.

Different methods of weed control have been tried. During the summers of 1966 and 1967, the pool was raised two feet to elevation 634.0 feet, NGVD to provide more suitable depth for swimming at the beach and to submerge aquatic weeds for improved boating. It was also hoped that the reduction in sunlight intensity due to the increased depth would inhibit weed growth. From December 1970 through February 1971 the pool was lowered 6.5 feet below normal to elevation 625.5 feet, NGVD exposing about 140 acres of shoreline with the hope of freezing the weeds. The Project Manager considered these actions to have achieved a partial success in controlling the weeds. In October 1972 the conservation pool was treated with a commercial preparation called "Kuron," whose main ingredient is the herbicide Silvex. This achieved some success. There have been no attempts in recent years to control the weed growth.

(3) Hopkinton Lake – Elm Brook Pool. The Elm Brook Pool recreation area at Hopkinton Lake has been invaded by the non-native aquatic weed *Myriophyllum spicatum*, commonly known as "Eurasian water-milfoil." Once it becomes established in a lake, it can cause serious problems, and at Elm Brook Pool it was tangling boat propellers and interfering with fishing, and park rangers were concerned that it was harming the fisheries' habitat. After consultation with the state of New Hampshire and obtaining the proper permits, the Corps contracted to have the 100 worst acres treated with the herbicide 2-4 D in July 2003. Results were very successful and no significant reoccurrence of the milfoil was noticed in the treated areas by the end of the year. Fishermen were particularly pleased with the improved condition of the lake. In FY04 NAE plans to treat another 50 acres; after that they plan to monitor annually. Typically, these treatments last about 5 years. The project will never be free of milfoil, but controlled herbicide treatments can go a long way to help manage the problem.

(4) North Hartland Lake – Deweys Mill Pond. Deweys Mill Pond is just upstream of the North Hartland Lake conservation pool and within the boundaries of the Corps project. It was created by a dike that separates the pond from the Ottauquechee River. The pond is shallow and choked with rooted and floating macrophytes, which are ubiquitous throughout the water column. Aquatic vegetation commonly found in this pond in large numbers includes *Nymphaea odortata* (fragrant water lily), *Nuphar luteum* (bullhead lily), *Potamogeton* (pondweed), *Nitella*, *Ceratophyllum* (coontail), and *Elodea canadensis* (common waterweed). These plants grow so densely as to preclude most recreational uses for the pond during the aquatic macrophyte-growing season. Field data show midday dissolved oxygen concentrations below 5 ppm throughout most of the water column, indicating conditions that are stressful to fish life. A fish kill during the winter 2002/2003 emphasized the magnitude of this problem. FY03 was the third year of a special study of the pond, and plans for possible remedial dredging are being developed.

5. FY04 RESERVOIR WQ MANAGEMENT ACTIVITIES.

The size of NAE's FY04 Reservoir Water Quality Management Program was uncertain at the time this report was prepared because the Corps was still operating under continuing resolution authority, but it is likely to be close to the $237,000 FY03 program. Work items will likely include (1) baseline fixed station monitoring at class III and I with permanent pools, (2) priority pollutant scans at two or three projects, (3) continuation of the bathing beach and potable water quality monitoring, (4) continued search for the source of the high bacteria levels in the West Hill and

Union Village Dams watersheds, (5) carrying out fisheries studies at one or more projects, and (6) completion of water quality updates at specific projects.

6. OTHER WATER QUALITY STUDIES, INVESTIGATIONS, AND DESIGNS PERFORMED IN FY03

a. Merrimack River Study. In FY01 Water Management Section began working with Planning's Special Studies Section to develop a scope of work for a major study of the Merrimack River basin. With a drainage area of over 5,000 square miles, the Merrimack River is one of the most important river systems in New England. Over the past several decades significant improvements have been made to the overall quality of the Merrimack River due to Federal, state, local community, and private investment in water pollution control facilities. However, there are remaining water quality, water quantity, fish and wildlife habitat, and flooding concerns.

The cities of Lowell and Haverhill, Massachusetts and Nashua and Manchester, New Hampshire, and the Greater Lawrence Sanitary District, Massachusetts are each currently working to develop and implement long-term combined sewer overflow (CSO) control plans in compliance with the Federal Clean Water Act. Collectively, potential required CSO-related improvements might cost as much as one billion dollars over the next 20 years. It is unclear that beneficial uses will be achieved even with CSO expenditures of this magnitude. The communities are concerned that decisions regarding potential CSO mitigation are being mandated by State and Federal regulatory agencies without a clear understanding of all pollution sources to the river, the existing conditions in the river, and the benefits of the required mitigation. The communities believe it is important that decisions be based on good data and a scientific and engineering understanding of the river and watershed. Once this information is developed it can be used to guide decisions regarding CSO mitigation implementation.

To conduct this needed river assessment, the communities have formed an inter- municipal partnership to carry out the study. The Federal government, through the US Army Corps of Engineers water resources assessment authority, is providing financial and technical assistance. Corps involvement in this study is authorized by Section 729 of WRDA of 1986 entitled "Study of Water Resources Needs of River Basins and Regions" as amended by Section 202 of WRDA 2000. In addition, directed funding for this effort was provided in the fiscal year 2000 Energy and Water Development Appropriation Bill.

The purpose of this study is to develop a watershed management plan that will guide investments to achieve conditions that support feasible beneficial uses. This will be accomplished by conducting a water resources and ecosystem restoration investigation of the Merrimack River.

The study will be conducted in several phases. Phase I efforts will be aimed at identifying the current and potential future uses of the river, assessing the existing water quality conditions, identifying and quantifying pollutant loads to the river, developing model(s) to evaluate the effects of all existing pollutant loads including non-point sources, evaluating various CSO and non-CSO abatement strategies, and completing an initial inventory of potential ecosystem restoration projects in the watershed. Phase II efforts will be determined following the results of Phase I and undertaken based on availability of non-federal and federal funding. At this time it is anticipated that Phase II efforts may focus on in-stream flow issues, possible testing for non-standard water quality parameters, more detailed analysis of abatement alternatives, and providing for preliminary assessment of ecosystem restoration projects identified in Phase I.

The initial scope of work was finished early in FY02, and a contractor was selected to begin work in May 2002. A "Description of Existing Conditions" report was completed in January 2003, and an approved QAPP and Field Sampling Plan were completed in June. The first dry-weather water quality sampling was conducted on 30 June 2003 with additional samplings on 20 August and 12 September. Wet-weather sampling events were performed on 22-23 August and 19-20 September. A third and final wet-weather event was considered for October or November, but ice began forming on the Merrimack River in New Hampshire and it was decided to postpone it until spring or summer of FY04.

Additional tasks completed in FY03 include a "Modeling Methodology" and an "Inventory of Potential Uses" report, and draft reports on "Information on Sources of Pollutants" and "Hydrology and Hydraulics." Ongoing tasks include development of a screening-level model, data management program, and geographic information system. In addition to completing these tasks, water quality models are scheduled for development in FY04.

b. Surry Mountain Lake – Dwarf Wedgemussel Studies. The endangered dwarf wedgemussel, *Alasmidonta heterodon*, lives in the Ashuelot River below Surry Mountain Lake. Since the fall of 1990, the USFWS and NAE have had periodic consultations about the possible effects on this mussel of stream flow regulation by the project. Monitoring of the dwarf wedgemussel (DWM) population is neces-

sary to evaluate the effects of stream flow regulation, but this requires some type of excavation into the sediment, which is obviously disruptive to the mussels. Furthermore, it modifies, in some cases permanently, the substrate that forms the habitat not only for the DWM, but other mussels, invertebrates and vertebrates, and it creates a plume of suspended solids downstream. In FY03 NAE in cooperation with the USFWS began investigating the use of the tessellated darter (*Etheostoma olmstedi*) (TD), one of the possible hosts for the parasitic glochidia of the DWM, to monitor the DWM population.

To understand the connection between the DWM and TD, the DWM reproduction process must be reviewed. As is typical of freshwater mussels, DWM reproduction is complex. Spawning usually occurs in the late summer or fall. Embryos develop internally in the female into small bivalve larvae called "glochidia." These embryos are held over winter until spring or early summer when they are released. Once released from females, glochidia are obligate parasites, almost exclusively on fish. Glochidia either become attached to fish gills or external surfaces. Known hosts of DWM glochidia include tessellated darter, slimy and mottled sculpin, and juvenile Atlantic salmon, but only the TD is available to the Ashuelot River DWM populations. Once attached to a host, glochidia feed on fish tissue for a period of time. Eventually the larvae transform into a juvenile mussel, detach, from the host, and begin a free-living existence in the substrate.

The requirement of the DWM for the TD indicates that monitoring the TD might give an indirect method of monitoring the DWM without harming them. However, this would have to be tested by observing the populations of DWM and TD in the Ashuelot River below Surry Mountain Lake. Biologists from NAE would measure the TD population while a contractor, Ethan Nadeau from Biodrawversity, would count the DWM.

Different methods for collecting TD were considered. Backpack electrofishing was chosen as the most effective sampling technique for the variable habitat of the TD. However, there were concerns the electric current it uses could potentially disturb or the DWM; consequently, electro-fishing was limited to 50-meter sections of the stream upstream or downstream from where the DWM were counted. In an adjacent experimental area, NAE planned to seine and deploy minnow traps to compare sampling efficiency with electro-fishing. Since crustaceans seem to be a fare of choice for darters, traps will be baited with freeze-dried *Artemia*.

Weather and scheduling, but mostly weather, delayed start of the project until September, when still more heavy rain arrived. Beginning in September, mussels

start to migrate down into the sediment for the winter months as water temperatures drop and photoperiod changes. Add to that the very real limitation of working for extended periods (7-10 hours at a time) in cold weather and water, and it made early autumn a bad time to survey mussels. Since FY03 was the first year in what we hope will be a long-term study, it would set a bad precedent to conduct the survey in September since, for comparative purposes, all future surveys would also need to be conducted during the same period. For these reasons, NAE and USFWS agreed that the survey should be postponed until June or July of next year when conditions are better. Mussel researchers all along the East coast have lamented over wet weather and their inability to conduct surveys this year, so conditions on the Ashuelot were not exceptional.

c. Osgood Pond Aquatic Ecosystem Restoration Study. Like many fresh-water ponds in southern New Hampshire, Milford's Osgood Pond has experienced accelerated eutrophication and sedimentation in the last 20 years due to increased development in its watershed. Sedimentation and siltation have reduced the average depth of this 15-acre pond to 2 to 3 feet, with the result that it is heavily overgrown with aquatic weeds. These weeds greatly reduce the quality of the waterfowl and fish habitat in the pond, as well as severely reducing its recreational use.

Under Section 206 authority, the Corps is investigating ways to restore the ecology and health of Osgood Pond. The major feature of the proposed restoration project is removing accumulated sediment to a depth adequate to restore open water habitat. Construction would include drawdown of the pond and excavation of the bottom material to an average depth of about 6 to 8 feet with deeper depths in the middle.

In FY01 Water Management Section collected and analyzed water quality and sediment samples from the pond. An independent technical review of the project began at the end of FY02 and was completed in FY03, and the current schedule calls for construction to begin in FY04.

d. Straits Pond Reclamation Study. Straits Pond, on the border of Hull and Cohasset, Massachusetts, is a highly eutrophic tidal impoundment with a limited amount of flushing. Each summer, algal blooms and aquatic weeds develop into heavy mats that decay and release unpleasant odors. In addition, these mats provide breeding areas for swarms of midges and other annoying insects. The area of Straits Pond was originally part of the Weir River tidal marsh, but it has a long history of complaints by neighbors of nuisance weed growth and foul odors. Tide gates were installed under the bridge, through which the pond connects to the Weir River, to

stabilize the water level in the hopes of reducing complaints. However, the problems continued, at least in part because the gates are too small to allow maximum flushing. Gates are needed to prevent flooding of adjacent properties during storm tides or when local storm runoff coincides with a high tide, and also to prevent the pond from draining too low and exposing large areas of mudflats. The bridge is in dire need of repair, which makes for a good opportunity for replacing the gates. WMS is modeling existing and proposed gate designs to evaluate the best options for improving circulation, water quality, and habitat in Straits Pond. Site visits, data collection, and initial modeling were completed in FY03, and final modeling is scheduled for completion in FY04.

e. Salt Marsh Restoration Studies. Under section 206 authority, NAE is conducting feasibility studies on restoring the ecology and health coastal salt marshes and ponds in Massachusetts, Rhode Island, and Maine. Coastal road construction over the past 50 years has often degraded salt marshes when the culverts installed were too small and reduced tidal exchange. Problems that can develop when tidal flushing is restricted include growth of nuisance species such as phragmites, increased sedimentation, and nutrient buildup with resultant algal blooms. The latter problem is often exacerbated by residential development, which increases nutrient loadings. These restricted culverts also reduce tidal flooding with the result that development often encroaches on the marsh. Consequently, study is needed to determine the optimal culvert size to maximize tidal exchange without causing property damage from flooding. Initiated or ongoing studies in FY03 include Billings Creek and Broad Meadows in Quincy, Plumbush Creek in Newbury, Run Pond in Yarmouth, Stewarts Creek in Hyannis, and Town Pond (a.k.a. Boyd's Marsh) in Quincy, Massachusetts; Allins Cove in Barrington, Rhode Island; and Scarborough Marsh in Scarborough, Maine.

f. HTRW Cleanups. Water quality concerns are a major part of HTRW projects. Contaminated soil and groundwater are the most commonly encountered problems. Because of ground water mobility, water quality can be both the most important and complicated aspect of cleanups. In FY03 WMS was involved in groundwater sampling as part of long-term monitoring of the cleanup of former military sites in Massachusetts and Rhode Island.

7. TRAINING AND ATTENDANCE AT WATER QUALITY MEETINGS AND CONFERENCES

Water quality related training and conferences in WMS included the following. In December and June, Mr. Barker represented NAE at Technical Advisory Group Meetings from the Willimantic Watershed Project at the University of Connecticut campus in Storrs. Also in June, Mr. Barker attended the NAD Annual Water Control/Water Quality Conference at Raystown Lake in Pennsylvania. In April Nancy McNally went to White River Junction, Vermont for the Northeast Rural Water Association's Water System Seminar for Campgrounds and other TNC Systems. Ms. McNally attended a seminar in May on Beach Water Quality Monitoring that was given in Marlboro, Massachusetts.

8. USE OF CORPS LABS IN FY03

NAE did not contract work to Corps Labs in FY03.

9. USE OF CONTRACT LABS IN FY03

NAE uses contract labs to perform all analyses for its water quality program. Labs used in FY03 included Spectrum Analytical in Agawam, Microbac in Marlborough, and the Wall Experiment Station in Lawrence, Massachusetts; Northeast Laboratories Inc. in Berlin, Connecticut; Environmental Alternatives, Inc. (formerly Biological Services) in Keene, New Hampshire; Aquacheck Water Testing Laboratory, in Weathersfield and the LaRosa Environmental Laboratory in Waterbury, Vermont. Spectrum Analytical is used for priority pollutant analyses; Microbac for Massachusetts drinking water compliance an beach analyses, some Connecticut drinking water and beach bacteria analyses, all chlorophyll *a* analyses, and baseline nitrate analyses; Environmental Analyses, Inc for New Hampshire and some Vermont drinking water and beach bacteria analyses, Aquacheck Water Testing Laboratory for Vermont drinking water compliance and beach, and New Hampshire nitrate/nitrite analyses at wells; Northeast Laboratories for Connecticut drinking-water compliance samples; the LaRosa Environmental Lab for all total phosphorus, total nitrogen, and mercury analyses; and the Wall Experiment Station for DNA analyses.

10. DISTRIBUTION LIST

a. Corps of Engineers

North Atlantic Division
District Engineer
Chief, Engineering/Planning Division
Chief, Construction/Operations Division
Chief, Public Affairs Office
Upper Connecticut River Basin Manager
Lower Connecticut River Basin Manager
Thames River Basin Manager
Naugatuck River Basin Manager
Merrimack River Basin Manager
Chief, Geotechnical and Water Management Branch
Chief, Operations Technical Services Branch
Chief, Evaluation Branch
Mr. Hubbard
Mr. Williams
Mr. Trinchero
Mr. Barker
Mr. Levitt
Mr. Hays

b. Non-Corps

Secretary
Executive Office of Environmental Affairs
Saltonstall Building
100 Cambridge St
Boston, MA 02202

Director, Office of State Planning and Energy Programs
57 Regional Drive
Concord, NH 03301

Secretary
Agency of Natural Resources
103 South Main Street
Waterbury, VT 05671

Mr. Eban D. Richert, Director
State Planning Office
State House Station #38
184 State Street
Augusta, ME 04333-0001

Mr. Andrew McCloud, Acting Director
Department of Environmental Management
235 Promenade Street
Providence, RI 02908

Mr. Arthur J. Rocque, Jr., Commissioner
Department of Environmental Protection
79 Elm Street
Hartford, Connecticut 06106

Director
Water Management Branch
U.S. Environmental Protection Agency
J.F. Kennedy Federal Building
Boston, Massachusetts 02203

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Director
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Director and Chief Engineer
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Massachusetts Department of Environmental Protection
627 Main St
Worcester, Massachusetts 01608

APPENDIX A

EXPLANATION OF NAE RESERVOIR PROJECT WATER QUALITY CLASSIFICATION SYSTEM

EXPLANATION OF NAE RESERVOIR PROJECT WATER QUALITY CLASSIFICATION SYSTEM

The 31 projects maintained and operated by NAE are grouped into three categories, based on past and present water quality conditions. Five factors are used in the assignment of classes: (1) statements of project conditions in past NAE Annual Water Quality Reports, (2) State Water Quality Reports, including information on upstream watershed activity, (3) identifiable changes between inflow and discharge water quality, (4) frequency of violation of water quality criteria, and (5) existence of a conservation pool.

Simply stated, class I projects have high water quality, class II projects have minor or suspected water quality problems, and class III projects experience continuing water quality problems. Low level, fixed station monitoring is applied at class I and class II projects, and high level monitoring is applied at class III projects. Class III projects have the highest priority for intensive surveys or other special studies, and class II projects have a low priority. No intensive surveys are planned for class I projects.

APPENDIX B

STATE WATER QUALITY CLASSIFICATIONS
NAE PROJECTS

STATE WATER QUALITY CLASSIFICATIONS OF NAE RESERVOIR PROJECTS

Project	State	Classification
Ball Mountain Lake	VT	B
Barre Falls Dam	MA	A
Birch Hill Dam	MA	B
Black Rock Lake	CT	B
Blackwater Dam	NH	B
Buffumville Lake	MA	B
Colebrook River Lake*	MA	A
Colebrook River Lake	CT	AA
Conant Brook Dam	MA	A
East Brimfield Lake	MA	B
Edward MacDowell Lake	NH	B
Everett Lake	NH	B
Franklin Falls Dam	NH	B
Hancock Brook Lake	CT	B
Hodges Village Dam	MA	B
Hop Brook Lake	CT	B
Hopkinton Lake	NH	B
Knightville Dam	MA	B
Littleville Lake	MA	A
Mansfield Hollow Lake	CT	AA
Northfield Brook Lake	CT	B
North Hartland Lake	VT	B
North Springfield Lake	VT	B
Otter Brook Lake	NH	B
Surry Mountain Lake	NH	B
Thomaston Dam	CT	B
Lead Mine Brook	CT	A
Townshend Lake	VT	B
Tully Lake	MA	B
Union Village Dam	VT	B
West Hill Dam	MA	B
West Thompson Lake	CT	C/B
Westville Lake	MA	B

*Colebrook straddles the Massachusetts/Connecticut border.

APPENDIX C

RESERVOIR WATER QUALITY CONTROL MANAGEMENT REPORTS
NEW ENGLAND DISTRICT

Reservoir Water Quality Control Management Reports
New England Division
(Prepared through FY03)

Project	Report and Date
Connecticut.	
Black Rock Lake	Black Rock Lake Water Quality Evaluation, June 1983. Black Rock Lake Priority Pollutant Scan, March 2000
Colebrook River Lake	Colebrook River Lake Water Quality Evaluation, June 1983. Colebrook River Lake Dissolved Gas Supersaturation Study, August 1984. Colebrook River Lake Priority Pollutant Scan, September 1997.
Hancock Brook Lake	Hancock Brook Lake Water Quality Evaluation, June 1983. Hancock Brook Lake comprehensive Fisheries and Water Quality Investigation (1991 - 1992), Plymouth, Connecticut. Hancock Brook Lake Priority Pollutant Scan, March 2000.
Hop Brook Lake	Hop Brook Lake Water Quality Evaluation, August 2003. Hop Brook Lake Water Quality Evaluation, April 1983. Hop Brook Lake Water Quality Evaluation Update, August 1984. Hop Brook Lake Nutrient Balance Study, August 1987. Hop Brook Lake Fisheries Assessment, April 1987. Hop Brook Lake Destratification Study, August 1985. Hop Brook Lake Summary of Limited Biological Survey, May 1981. Hop Brook Lake Close Interval Sampling, Sediment and Algal Progression Study, May 1990. Hop Brook Lake Water Quality Study (Interim Report), June 1990. Hop Brook Lake Water Quality Study (Interim Report), April 1993. Hop Brook Lake, Connecticut, Priority Pollutant Scan, August 1993.
Mansfield Hollow Lake	Mansfield Hollow Lake Water Quality Evaluation, June 1983. Mansfield Hollow Lake Water Quality Evaluation, July 1988. Mansfield Hollow Lake Priority Pollutant Scan, September 2000.
Northfield Brook Lake	Northfield Brook Lake Priority Pollutant Scan, March 2003 Northfield Brook Lake Water Quality Evaluation, January 1983. Priority Pollutant Scan of an Unnamed Brook at Northfield Brook Lake July 1992
Thomaston Dam	Thomaston Dam Water Quality Evaluation, April 1983. Brown Trout Habitat Suitability at Thomaston Dam, Connecticut, February 1987. Limnological Survey at Thomaston Dam, Connecticut, March 1987. Thomaston Dam, Water Quality Evaluation, June 1991. Thomaston Dam, Connecticut, Priority Pollutant Scan, August 1994.

Connecticut. (cont.)

West Thompson Lake	A Biological and Chemical Survey of Algal Blooms at West Thompson Lake, Connecticut, August 1979. West Thompson Lake Water Quality Evaluation, April 1983. West Thompson Lake Water Quality Evaluation Update, June 1984. Final Report on the West Thompson Lake Algae Control Study, June 1986. West Thompson Lake Algal Progression Study, June-July 1988; Jan. 1989. West Thompson Lake Algal Progression Study, June-Sept. 1992; Feb. 1995. West Thompson Lake, Connecticut, Priority Pollutant Scan, December 1994.

Massachusetts.

Barre Falls Dam	Barre Falls Dam Water Quality Evaluation, August 2003 Barre Falls Dam Water Quality Evaluation, June 1983. Barre Falls Dam, Massachusetts, Priority Pollutant Scan, January 1995.
Birch Hill Dam	Birch Hill Dam Water Quality Evaluation, April 1983. Birch Hill Dam Water Quality Evaluation, July 1987. Birch Hill Dam, Priority Pollutant Scan, Interim Report, July 1988. Birch Hill Reservoir PCB Investigation, July 1989. Birch Hill Reservoir PCB Investigation, September 1990. Birch Hill Reservoir PCB Investigation, Phase I, October 1991. Birch Hill Reservoir PCB Study, March 1992
Buffumville Lake	Buffumville Lake Water Quality Evaluation, August 2003 Buffumville Lake Water Quality Evaluation, January 1983. Buffumville Lake Water Quality Evaluation Update, May 1984. Buffumville Lake Water Quality Evaluation, August 1985. General Limnological Survey, Buffumville Lake, 1985.
Charles River NVSP	Charles River NVSP Water Quality Assessment, June 1987.
Conant Brook Dam	Conant Brook Dam Water Quality Evaluation, June 1983. Conant Brook Dam Priority Pollutant Scan, April 2000.
East Brimfield Lake	General Limnological Survey, The East Brimfield Project/Lake. 1982. East Brimfield Lake Water Quality Evaluation, January 1983. East Brimfield Lake Water Quality Evaluation Update, September 1984. East Brimfield Lake - Iron, July, 1996.
Hodges Village Dam	Hodges Village Dam Water Quality Evaluation, April 1983.
Knightville Dam	Knightville Dam Water Quality Evaluation, June 1983. Knightville Dam Fishery Assessment, Huntington, Massachusetts, May 1989 Westfield River Projects, Priority Pollutant Scan, April 2002

Massachusetts. (cont.)

Littleville Lake	Littleville Lake Water Quality Evaluation, January 1983. Fisheries Assessment, Littleville Lake, 1987. Westfield River Projects, Priority Pollutant Scan, April 2002
Tully Lake	Tully Lake Water Quality Evaluation, June 1983. Tully Lake Evaluation of Effects of Flood Control Project Operations on Water Quality, September 1984. Tully Lake Fisheries Investigation (June-August 1993)
West Hill Dam	West Hill Dam Water Quality Evaluation, April 1983. West Hill Dam Priority Pollutant Scan, April 1999
Westville Lake	Westville Lake Water Quality Evaluation, January 1983.

French River Projects Priority Pollutant Scan, January 1999

New Hampshire.

Blackwater Dam	Blackwater Dam Water Quality Evaluation, June 1983.
Edw. MacDowell Lake	Edw. MacDowell Dam Water Quality Evaluation, January 1983.
Everett Lake	Everett Lake Water Quality Evaluation, September 1982. Everett Lake Water Quality Evaluation, January 1983.
Franklin Falls Dam	Franklin Falls Dam Water Quality Evaluation, April 1983. Franklin Falls Dam Water Quality Evaluation, April 1984. General Limnological Survey, Franklin Falls Dam, 1984. Priority Pollutant Scan, November 2000.
Hopkinton Lake	Hopkinton Lake Water Quality Evaluation, September 1982. Hopkinton Lake Water Quality Evaluation, April 1983. Elm Brook Pool Water Quality Evaluation, September 1982. Hopkinton Lake, Priority Pollutant Scan, June 1988. Hopkinton Lake, An Assessment of the Fishery, November 1995.
Otter Brook Lake	Otter Brook Lake Water Quality Evaluation, April 1983. Otter Brook Lake Evaluation of Effects of Flood Control Project Operations on Water Quality, May 1984. Otter Brook Lake, New Hampshire Fisheries Assessment, November 1987. Otter Brook Lake, New Hampshire, Priority Pollutant Scan, February 1993.
Surry Mountain Lake	Surry Mountain Lake Water Quality Evaluation, June 1983. Surry Mountain Lake, New Hampshire Fisheries Assessment, Nov. 1987.

Vermont.

Ball Mountain Lake	Ball Mountain Lake Water Quality Evaluation, August 1982. Ball Mountain Lake Water Quality Evaluation, June 1983. Ball Mountain Lake Water Quality Evaluation, September 1987.
North Hartland Lake	North Hartland Lake Water Quality Evaluation, August 1982. North Hartland Lake Water Quality Evaluation, January 1983. North Hartland Lake Water Quality Evaluation, September 1986. Smallmouth and Largemouth Bass Suitability at North Hartland Lake, Vermont, November 1987.
No. Springfield Lake	North Springfield Lake Water Quality Evaluation, August 1982. North Springfield Lake Water Quality Evaluation, April 1983. Stoughton Pond at North Springfield Reservoir Water Quality Evaluation, August 1982. North Springfield Lake Fishery Assessment, North Springfield and Weathersfield, Vermont, May 1989. North Springfield Lake Fisheries Investigation, and Status of Largemouth Bass Fishery in 1991, North Springfield and Weathersfield, Vermont, May 1996.
Townshend Lake	Townshend Lake Water Quality Evaluation, September 1982. Townshend Lake Water Quality Evaluation, June 1983. Atlantic Salmon Suitability at Townshend, Vermont, November 1987.
Union Village Dam	The Effects of Mine Drainage at the Union Village Project, (A Preliminary Biological and Chemical Survey), March 1980. Union Village Dam Water Quality Evaluation, January 1983. Union Village Dam Water Quality Evaluation Update, August 1984. Union Village Dam Water Quality Evaluation, September 1989.

Vermont Lakes Priority Pollutant Scan, June 1998

APPENDIX D

SAMPLE BEACH-MONITORING FORM

WQ 2003

ACOE MA. FRESHWATER BEACHES

FIELD DATA

Date: COLLECTED BY

Sample ID	TM2B		B02		WH02	
Location*	Tully Lake		Buffumville Lake		West Hill Park	
Amount of last Precip.						
# of Days since precip.						
Time Collected						
Visitor/Swimmer Density						
Water Temp °F						
Air Temp °F						
Water Clarity - Clear?	no	yes	no	yes	no	yes
Beach freshly raked?	no	yes	no	yes	no	yes
Animal debris present	no	yes	no	yes	no	yes
Describe animal debris (quantity/type)						
Plant debris present	no	yes	no	yes	no	yes
Describe plant debris (quantity/type)						
Number of geese/ducks in vicinity						
Algal bloom present?	no	yes	no	yes	no	yes
Algae description : color	bright green brown red green		bright green brown red green		bright green brown red green	
Algae appearance	small medium large free-swimming sphere colony filaments mats gelatinous floating dispersed thru column submerged		small medium large free-swimming sphere colony filaments mats gelatinous floating dispersed thru column submerged		small medium large free-swimming sphere colony filaments mats gelatinous floating dispersed thru column submerged	
Extent of algal coverage						
Notes						